SANTA CLARA VALLEY WATER DISTRICT

PERMANENTE CREEK WATERSHED PLANNING STUDY

PROJECT BACKGROUND/ PROBLEM DEFINITION REPORT

Project No. 102401

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Preface

The Permanente Creek watershed study area consists of Permanente Creek, from San Francisco Bay to Foothill Expressway, Hale Creek from its confluence with Permanente to Foothill Expressway, and the Permanente Diversion Channel (see Figure 1 – Project Area).

The first part of this report describes the background of this study, the origin, the purpose, and the objectives. All previous studies, projects, programs, and regulations of the District and others that impact the study area are described. The cities and major property owners in the watershed and their general policies regarding creeks are discussed.

Part two of this report describes the baseline or current conditions of the creeks in the watershed study area. Descriptions of the watershed hydrology, physiography and geology are provided. This section of the report also discusses the historical stream channels and the various man-made changes to the channels through time.

Part three describes various currently identified problems in the study area. Historical flooding is summarized. Current channel capacities and the existing flooding problems are discussed. Other problems identified and discussed include lack of maintenance access, sedimentation, water quality, channel bank and invert erosion, and the structural deterioration of the existing creek facilities.

Finally, this report describes what would likely happen if no actions were taken to address the problems described above.

I. Background

A. Objectives

As a “Clean Safe Creeks” project (projects funded by the voter-approved Measure B) the project is required to provide Natural Flood Protection, which is defined as follows:

> *Providing environmental quality, community benefit and protection from creek flooding in a cost effective manner through integrated planning and management that considers the physical, hydrologic and ecologic functions and processes of streams within the community setting*

Natural Flood Protection Objectives for all Clean Safe Creek projects are:

- Provide protection from flood damage
- Support ecological functions and processes
- Integrate physical stream functions and processes

- Minimize maintenance requirements
- Integrate within the context of the watershed
- Protect the quality and availability of water
- Cooperate with other agencies to achieve mutually beneficial goals
- Maximize community benefits beyond flood protection
- Minimize life cycle costs

More specific objectives of this study are the following:

- Provide flood protection to 1,664 parcels (1,378 homes, 160 businesses and 4 schools/institutions) in Mountain View from a 100-year (one-percent) flood, saving potential damages in excess of $47.9 million.
- Prevent flooding of Middlefield Road and Central Expressway.
- Evaluate natural flood protection that includes stream habitat restoration, removal of invasive plants, revegetation of native species and the incorporation of trails and open space.
- Address the deterioration of aging facilities of the existing flood control channel along Permanente Creek and Hale Creek pursuant to Board Policy No. E-2, Section 2.2.2.1.
- Address the necessity of repairing localized bank erosion if it has an impact on water quality, ecological functions, or physical stream functions.
- Develop maintenance guidelines and obtain associated long-term permits to achieve flood protection/restoration objectives.
- Minimize long-term maintenance costs.
- Consider opportunities for a continuous maintenance corridor along the creeks.
- Protect the Watershed's current environmental resources and identify opportunities for environmental enhancements such as stream restoration, as well as trails, parks, and open space, pursuant to Board Policy No. E-3, Section 3.2.
- Identify and evaluate opportunities for regional treatment of storm water.

B. Previous District Engineering Studies and Improvement Projects

This section briefly describes previous District engineering studies, improvement projects, and major maintenance projects. Projects are described in chronological order

Figure 1 – Project Area

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Permanente Diversion Channel

In 1956, a "Preliminary Report on the Improvement of a Portion of Permanente Creek in Zone NW-1, Project 3" was prepared by Thelo A. Perrot Consulting Engineer for the Santa Clara County Flood Control and Water Conservation District. The report was prepared in response to the 1955 flooding, and proposed the construction of a diversion channel which would carry high flows from Permanente Creek to Stevens Creek.

The concrete trapezoidal Permanente Diversion channel was constructed circa 1960. An earthen trapezoidal channel was also constructed on Permanente Creek downstream of Portland Avenue. The work is detailed in the 1959 "Permanente Creek Cross Channel" plans.

Hale Creek Improvements

In 1956, a "Preliminary Engineering Report, Hale Creek Improvement Project No. 9, Zone NW-1" was prepared by Don Reinoehl Consulting Engineers for the Santa Clara County Flood Control and Water Conservation District. The study recommended numerous improvements to Hale Creek, including lining portions of the invert with concrete, building a debris basin upstream of Fremont Ave., and replacing six bridges and culverts.

Based on this work, in the early 1960's a concrete-lined trapezoidal channel was constructed on Hale Creek beginning at the confluence with Permanente Creek and extending upstream to Rosita Avenue. This work is detailed in the "Hale Creek Improvement Zone N.W.-1 "Northwest"; Project No. 9, Unit 1" plans dated 1959 and 1960.

Permanente Creek - Bay to Highway 101

In the early 1960's, a trapezoidal channel was constructed on Permanente Creek from Mountain View Slough to Highway 101. Portions of the channel were lined with concrete, but the majority of the channel was unlined. The work is detailed in the 1960 "Permanente Creek Improvements" plans.

Permanente Creek Vertical-Walled Concrete Channel

In 1961, a soils report entitled "Proposed Improvements of Permanente Creek" was prepared by Cooper & Clark Consulting Engineers for the Santa Clara County Flood Control and Water Conservation District. The study consisted of the analysis of 9 soil borings from Highway 101 to Mountain View Ave. to determine if the soils were suitable for the construction of a concrete vertical walled channel.

In 1962 a vertical-walled concrete channel was constructed from El Camino Real to Hale Creek. The work is detailed in the 1962 "Permanente Creek - Hale Creek to El Camino Real" plans.

In 1967 a vertical-walled concrete channel was constructed on Permanente Creek from Highway 101 to Villa St. The project is detailed in the 1965 plans, "Permanente Creek - Bayshore Highway to Villa St."

Permanente Creek - Villa St. Culvert and California/El Camino Culvert

In the early 1960's, two box culverts were constructed: the Villa St. culvert and the California/El Camino culvert. A concrete-line trapezoidal channel was constructed between the two culverts. The work is detailed in the following plans: "Permanente Creek - El Camino Real to Latham St", 1962; "Permanente Creek - Villa St. to 485 ft. South of Villa St.", 1963; "Permanente Creek - 485 ft. South of Villa St. to California St.", 1964; and "Permanente Creek, California St. to Latham St., 1964.

Mountain View Slough Studies

In 1964, the Santa Clara County Flood Control and Water District prepared a "Report on a Study of Drainage of the Mountain View Bay Front Area and Permanente and Stevens Creeks Outfall Channels." The report proposed that a slotted weir be installed to reduce sedimentation in Mountain View slough. The report also studied methods of draining the lowland areas near the Bay in Mountain View; the study concluded that pumping is the most effective method of draining these areas.

In 1966 the "Mountain View Slough Slotted Weir Study" was prepared by Lynne Burst for the District. This study concluded that a slotted weir in Mountain View Slough, as proposed in the 1964 study, would not be effective in reducing sedimentation in the slough. The slotted weir was therefore not installed.

Mountain View Slough - East Levee Raising

In 1976 the Final Environmental Impact Report on the Proposed Mountain View Slough Levee Repair Project was prepared by the Santa Clara Valley Water District. The report studies the environmental impacts of raising the eastern levee of Mountain View Slough.

In 1993 the eastern levee of the Mountain View Slough was raised. This work is detailed in the 1993 plans, "Permanente Creek, Mt. View Slough East Levee Raising and Maintenance Access Road". The West levee was not altered.

Permanente Creek and Permanente Diversion Planning Study and Improvements

The 1979 "Permanente Creek Planing Study, Final Engineer's Report" addressed flooding, erosion, and sedimentation problems on Permanente Creek from Portland Avenue to Hale Creek and along the Permanente Diversion Channel. The plan recommended modifications to the diversion channel and to the creek near Portland Avenue which would provide 25-year protection to that area. The plan also proposed flood-proofing El Camino Hospital to provide one-percent flood protection. Construction of reservoirs in the upper portion of the watershed was evaluated but could not be justified due to a low benefit/cost ratio.

In 1981 the following work was performed on Permanente Creek: the trapezoidal channel downstream of Portland Avenue was lined with concrete; and sacked concrete was installed in the channel upstream of Cuesta Drive and downstream of Marilyn Drive. In 1981 the following work was also performed on the Permanente Diversion Channel: a 183-centimeter (72-inch) pipe was installed under Blach Jr. High School to supplement the capacity of the existing double box culvert; floodwalls near Carmel Terrace were raised; and the Diversion Channel entrance to the box culvert under Highway 85 was modified. This work was detailed in the 1980 plans "Permanente Diversion and Permanente Creek."

In 1981 El Camino Hospital was flood-proofed to ensure that the Hospital was protected against the one-percent flood. Flood-proofing measures included the installation of earth mounds, floodwalls, and ramps.

Permanente Diversion - Remedial Measures at Blach School

In 1984 a study entitled "Permanente Diversion Channel Remedial Flood Control Measures (at Altamead Drive and Blach School), Engineer's Report and Negative Declaration", was prepared to address flooding, sediment and maintenance problems on the Permanente Diversion near Altamead Drive. The study proposed removing the existing buried culverts and replacing them with a vertical-walled open channel in order to allow for easier sediment removal. The study was prepared in response to the 1983 flooding of Blach Jr. High School and surrounding areas.

In 1986 the double box culvert and the 183-centimeter (72-inch) pipe under Blach Jr. High School along the Permanente Diversion Channel were removed and replaced with a vertical-walled concrete channel. This work is detailed in the 1985 plans "Permanente Diversion Channel."

Study of Proposed Permanente Creek Flood Control Dam

In 1996 a report entitled "Preliminary Geologic Evaluation of Permanente Creek for the Proposed Siting of a Flood Control Dam" was prepared by the District to provide a preliminary reconnaissance evaluation of the geological conditions at a proposed dam site in the upper watershed of Permanente Creek. The study concluded that the proposed dam site may not be feasible due to geologic conditions. The study identified two alternative dam sites where geological conditions were more favorable; however, both of these locations would provide less flood storage.

To date, no flood control dam has been constructed in the watershed.

C. Previous Studies and Actions by Other Agencies

FEMA Floodplain Studies

In 1980, the Federal Emergency Management Agency (FEMA) published Flood Insurance Studies for the Cities of Mountain View and Los Altos. The purpose of these studies was to identify the existence and severity of flood hazards within these cities.

U.S.G.S. Sediment Studies

In 1989 the U.S. Geological Survey published the Water-Resources Investigations Report 89-4130, "Effects of Limestone Quarrying and Cement-Plant Operations on Runoff and Sediment Yields in the Upper Permanente Creek Basin, Santa Clara County, California. The report was prepared in cooperation with the District. The report quantified the impact of the upstream cement and aggregate quarry on creek sedimentation.

D. Cities and Major Property Owners Within the Watershed

City of Mountain View

The northern portion of the Permanente watershed lies within the City of Mountain View. This section describes the City's General Plan, as well as the City's Shoreline at Mountain View park and a proposed pedestrian trail along Permanente Creek.

General Plan

The City of Mountain View 1992 General Plan contains general Environmental Management policies, goals, and actions. Environmental Management Polices and Actions which may be related to flood management within the Permanente Watershed include the following:

Policy 3	Develop a system of urban trails in Mountain View. Build entry points, pathways, and bridges to link the urban trail system, and connect it with Shoreline at Mountain View
Policy 4	Improve and expand wildlife habitats next to Shoreline.
Policy 10	Encourage compatible uses in the city's open spaces.
	Develop natural areas, creeks, and Shoreline for low-intensity uses such as walking, jogging, and environmental education.
Policy 11	Protect designated public open spaces from redevelopment.
	Use the flood plain to preserve open space lands.
Policy 16	Establish pollution control measures that keep pollutants from entering Mountain View's storm drain system to protect the city's surface water resources.
	Carry out the Santa Clara Valley Non-Point Source Pollution Control Program.
	Use "best management practices" in new projects to prevent storm water from becoming contaminated.
	Look into technologies to separate and remove pollutants from the storm sewer system and use them if appropriate.

Revise local ordinances and, if necessary, develop new ordinances to limit non-point source pollution.

Policy 22 Encourage soil stabilization measures that prevent soil erosion and sedimentation.

Protect and preserve existing planed communities next to creeks to help prevent erosion.

Policy 25 Protect and restore plant and wildlife habitat

Use open space zoning districts and capital projects to preserve and enhance creekside habitats.

Policy 26 Protect wildlife from the hazards of urbanization.

Preserve Shoreline's burrowing owl habitat by passing an ordinance designating Shoreline as a burrowing owl preserve.

Policy 32 Protect residents and their property from flood hazards.

Work with the Federal Emergency Management Agency and the Santa Clara Valley Water District to update the city's Flood Insurance Rate Maps.

Distribute flood maps to educate residents and developers about flood hazards in the community.

Enforce the City's Drainage and Flood Control Ordinance.

Coordinate with the Santa Clara Valley Water District to maintain and improve flood control programs and facilities.

Analyze the City's storm drain system for possible inadequacies and, if necessary, develop Capitol Improvement Programs to improve the system.

Shoreline at Mountain View

Shoreline at Mountain View is a regional park and nature preserve owned by the City of Mountain View which encompasses 2.52 square kilometers (622 acres). Shoreline at Mountain View is located at the extreme northern end of the City of Mountain View, and is bounded by Amphitheater Parkway to the south and salt ponds to the north. Permanente Creek runs south to north through the center of the park.

The park contains approximately .96 square kilometer (237 acres) of wetland habitat, 0.78 square kilometer (195 acres) of upland habitat, a 0.81 square kilometer (200 acre) golf course, and a sailing lake. The Mountain View Tidal Marsh is located on the east side of the main channel of Permanente Creek, just upstream of the salt ponds. The Mountain View Tidal Marsh is a part of Mountain View Slough, and is connected to the main channel of Permanente Creek.

Shoreline Lake is a small salt-water lake used primarily for windsurfing. The lake is maintained by pumping water into to the lake from the Bay, and discharging the overflow into Permanente Creek at an outfall near Shoreline Boulevard.

Prior to the development of Shoreline at Mountain View, a sanitary landfill was created on site. The landfill served the dual purpose of raising money to fund the park, and raising the elevation of the site to reduce the risk of flooding. The large hill (Vista Slope) located on the eastern side of Permanente Creek immediately north of Amphitheater Parkway marks the remains of the inactive landfill. Shoreline Amphitheater, a large outdoor concert venue, is located adjacent to the Vista Slope and Shoreline at Mountain View.

Proposed Permanente Creek Pedestrian Trail

The "City of Mountain View Permanente Creek Development Guidelines" (1996) describes plans for a 1.6 Kilometer pedestrian and bicycle trail along the east side of Permanente Creek between Highway 101 and Shoreline Boulevard. Portions of the proposed trail are located within lands held through fee title or easement by the Santa Clara Valley Water District.

City of Los Altos

The central portion of the Permanente watershed lies within the City of Los Altos.

General Plan

Goals and policies of the Los Altos 1987-2005 General Plan which may be related to flood contain management within the Permanente Watershed include the following:

Open Space, Conservation, and Community Facilities

Goal 1: Preserve and protect natural areas-natural creek channels, topography, and vegetation-which are valuable natural resources.

Creeks and creekside areas should be retained in their natural state while ensuring public safety and preserving a valuable natural resource.

The City shall take an active role in promoting the adoption of a regional stream management plan.

The City shall establish buffers from adjoining land uses to protect the natural state of all creekside areas.

Establish a program to educate the public on the sensitive nature of riparian lands and appropriate use of those and adjoining lands, in coordination with the open space management plan.

Establish easements over creeks. Require minimum setbacks for structures within the easements.

Goal 4: Develop and promote a pathways system within the city which also connects to open space in surrounding areas.

Identify and develop a program to establish, when possible, those sections of creeks within Los Altos that would be feasible for pedestrian pathways.

Natural Environment and Hazards

Goal 3: Reduce the potential for flooding along creeks that traverse Los Altos.

The City shall work with other jurisdictions to regulate land uses in flood-prone areas and should allow development in those areas only with approved mitigation.

The City shall identify and seek sources of funding to be used toward the prevention of flooding.

The City shall continue to discourage concrete lining of creek beds, and shall encourage the Santa Clara Valley Water District to use environmentally sensitive solutions to control local erosion problems.

Annually review areas identified on the Development Constraints Diagram as subject to flooding.

Encourage the Santa Clara Valley Water District to regularly maintain creek banks, to clear drainage channels of silt and debris, and to minimize disruption to riparian habitat in an environmentally sensitive manner.

Analyze bridge structures for constructions that cause siltation or erosion.

Enforce measures to reduce soil erosion and volume and velocity of surface runoff form construction sites and large parking lots to other impermeable surfaces. Work with other jurisdictions to ensure that development along creeks will not cause erosion which will affect Los Altos.

Goal 7: Abate non-point source water pollution

The City shall seek to ensure that surface runoff water discharges into the storm water system comply with the National Pollutant Discharge Elimination System permit and the receiving water limitations assigned by the California Regional Water Quality Control Board.

The City shall establish nonpoint source pollution control measures and programs to attempt to reduce and control the discharge of pollutants into the City's storm drains and local creeks.

Implement, where feasible, the Nonpoint Source Program including the City's local storm water management program.

Rancho San Antonio County Park and Rancho San Antonio Open Space Preserve

Rancho San Antonio County Park is located in the foothills southwest of Highway 280 and immediately north of the Hanson Cement Plant and limestone quarry. The Park is located within the Permanente watershed. Permanente Creek runs through the center of the Park. The 0.7 square kilometer (165 acre) park is mostly undeveloped and contains several hiking, biking, and equestrian trails. Most of the park’s development is located along the eastern side of the park; developments include parking lots, picnic areas, tennis, handball and basketball courts and playing fields. The Park is owned by the County but operated by the Mid-Peninsula Regional Open Space District (MPROSD)

Rancho San Antonio Open Space Preserve, which is owned and operated by MPROSD, is located in the foothills southwest of Highway 280, immediately west of Rancho San Antonio County Park. The majority of the park's 8.6 square kilometers (2,135 acres) of open space lie within the Permanente Watershed, and most of West Branch Permanente Creek and Ohlone Creek are located within the Preserve. Development within the park includes the Deer Hollow Farm, an interpretive farm which is open to the public, and 37 km (23 miles) of hiking and equestrian trails.

Hanson Cement Plant and Limestone Quarry

The Hanson (formerly Kaiser) Cement Plant and Limestone Quarry is located in the upper Permanente Creek Basin. The limestone mined from the quarry is used for the on site production of cement. The quarry and cement plant operations directly affect over 1.2 square kilometers (300 acres) of the upper Permanente Creek Basin. Minor quarry operations began in 1900; operations increased in 1939, when large amounts of cement were produced for Shasta Dam. Operations have continued at large scale up to the present time. Based on discussions with plant management, plant operations will continue into the foreseeable future.

Cargill Salt Ponds/ Federal Wetlands Restoration Area

Salt evaporation ponds formerly owned by Cargill Incorporated (formerly Leslie Salt Co.) covering a total area of over 3.2 square kilometers (800 acres), are located adjacent to both sides of Permanente Creek (Mountain View Slough). The salt ponds are bound to the North by San Francisco Bay, and to the South by Shoreline at Mountain View. These two ponds are the first two in the salt-making chain that ringed the south Bay; therefore, they are the least saline of the salt ponds.

Both the East and West levees were owned by Cargill. The District had an agreement with Cargill to maintain the East levee at an elevation of 9.5 feet above mean sea level; the District has no responsibility to maintain the West levee. The ponds have been purchased by the U.S. Fish and Wildlife Service for the South Bay Salt Pond Restoration Project, which is a long-term planning effort underway to determine the restoration plan for the ponds.

II. Existing Conditions

A. Permanente Watershed Description

The Permanente watershed lies within the Northwest portion of Santa Clara County and is in the District's Lower Peninsula Flood Control Zone. The lower portions of the watershed lie within the cities of Mountain View and Los Altos, while the upper watershed is located in an unincorporated area of Santa Clara County (see Figure 2 – Watershed Map). Water flows from the Santa Cruz Mountains in the South to the floor of the Santa Clara Valley and the San Francisco Bay in the North.

The major tributaries to Permanente Creek are Hale Creek, West Branch Permanente Creek, and Ohlone Creek. Tributaries to Hale Creek include Magdalena Creek, Loyola Creek and Summerhill Channel. Because a majority of the flows from the upper Permanente watershed area are diverted to Stevens Creek through the Permanente Diversion Channel, the two watersheds are related. Therefore, the lower reaches of Steven’s Creek (downstream of the Diversion) were also studied as part of this report.

Hale Creek has a watershed area of approximately 10.4 square kilometers (4 square miles); while the Permanente Creek watershed area is approximately 45.3 square kilometers (17.5 square miles).

The Permanente Creek watershed has a Mediterranean climate characterized by mild, wet winters, and warm, dry summers. The distribution of rainfall is strongly affected by topography. Rainfall levels are highest in the upper watershed area in the Santa Cruz Mountains and lowest by San Francisco Bay. Average annual rainfall ranges up to 91 centimeters (36 inches) per year in the highest sections of the hills, while the average annual rainfall near the Bay is only 33 centimeters (13 inches). Over 80 percent of the seasonal precipitation occurs between November and March. The steep topography of the upper watershed results in short duration, high intensity runoff during major storms. Runoff in the lower, urbanized section of the creeks is conveyed to the creeks by the municipal storm drain system, which tends to increase the magnitude of the more frequent events, while partially controlling the magnitude of very large events.

B. Creek Descriptions

This section presents brief descriptions of the reaches of Permanente Creek, Hale Creek, the Permanente Diversion, and Stevens Creek in the study area. Permanente Creek is described between San Francisco Bay and Foothill Expressway, Hale Creek is described from its confluence with Permanente to Foothill Expressway, the Permanente Diversion Channel is described in its entirety, and Stevens Creek is described between San Francisco Bay and the Diversion.

In each case, the following information is provided:

Reach: the creek reach being described is identified (see Figure 3 – Reach Definitions).

Channel Description: a general description of the existing condition of the channel is provided.

Right-of-Way: the existing SCVWD rights-of-way (if any) extent and type are identified.

Average Reach Slope: the average slope of the reach is shown. Note that drop structures have been installed along most channel reaches, reducing the effective slope for the channel.

1% Flow: the design one-percent flowrate for the reach is provided.

10% Flow: the design ten-percent flowrate for the reach is provided.

Current Reach Capacity: the existing reach capacity is shown, and the calculated existing condition one-percent and ten-percent flows are identified. The reach capacity is the maximum flow the reach can currently convey without flooding (with zero freeboard). These capacities were developed for each individual bridge-to-bridge channel reach and for each individual bridge, so that there would be no backwater effects from downstream reaches to unduly restrict other reaches' capacities. The idea was to determine which particular reaches and culverts are causing particular flood capacity problems.

Roughness Coefficient: the reach roughness coefficient (Manning's number "n") is identified.

Typical Channel Photos: color photographs of the existing channel are provided (with the location and date of the photo identified) for each reach.

PERMANENTE CREEK

Reach P1: San Francisco Bay to upstream end of Salt Ponds (Sta 0+000 to Sta 1+950)

Reach Description:
The reach is an earth levee channel with saline and brackish marsh vegetation. For the most part, the reach is a wide channel with a low flow (tidal) channel meandering through it. The salt ponds are located on both sides of the creek. It is difficult to gain access along this reach since there are no access points into the channel, and the maintenance/pedestrian road further upstream on the west bank stops at the upstream end of the salt ponds.

Right of Way: The District has no easements in this reach

Figure 2 – Watershed Map

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Figure 3 – Reach Map

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Reach Slope: 0.0001 (slope measurement from 0+185 to 1+913)

1% Flow: 65 cms (2300 cfs)

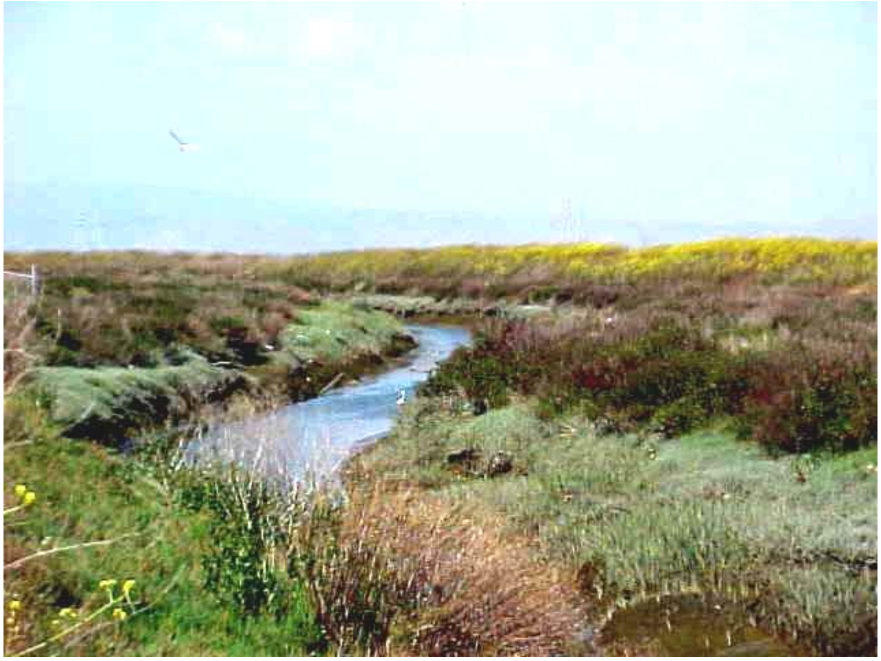
10% Flow: 34 cms (1200 cfs)

Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
San Francisco Bay to U/S end of Salt Ponds	26	900

Reach Roughness Coefficient: Composite channel roughness is 0.056

Typical Channel Photos:



5/02/02 – Upstream end of Salt Ponds
The channel consists of vegetated earth levees and meanders through tidal marshes and salt ponds. Vegetation in channel and on banks consists of grass, weeds, and thick, bushy undergrowth. Channel invert is clear of vegetation; channel material consists of silt and mud.

Reach P2: Upstream end of salt ponds to Highway 101 (Sta 1+950 to sta 3+956)

Reach Description: The reach is a natural channel with the vegetation consisting mainly of undergrowth such as grass, weeds, and bushes. From the salt ponds to Amphitheatre Parkway, the reach has a wide invert with a low flow channel meandering through it. From Amphitheatre

Parkway to Highway 101, the channel is trapezoidal earth. There are no access points into the channel but there are maintenance roads on both banks along most of the reach.

Right-of-Way: varies
1+973 to 3+304: 30m to 45m± (95ft to 150ft±) easement
3+327.5 to 3+955: 26.7m to 35m (87.5ft to 115ft) easement

Reach Slope: 0.001 (slope measurement from 2+093 to 3+951)

1% Flow: 65 cms (2300 cfs)

10% Flow: 34 cms (1200 cfs)

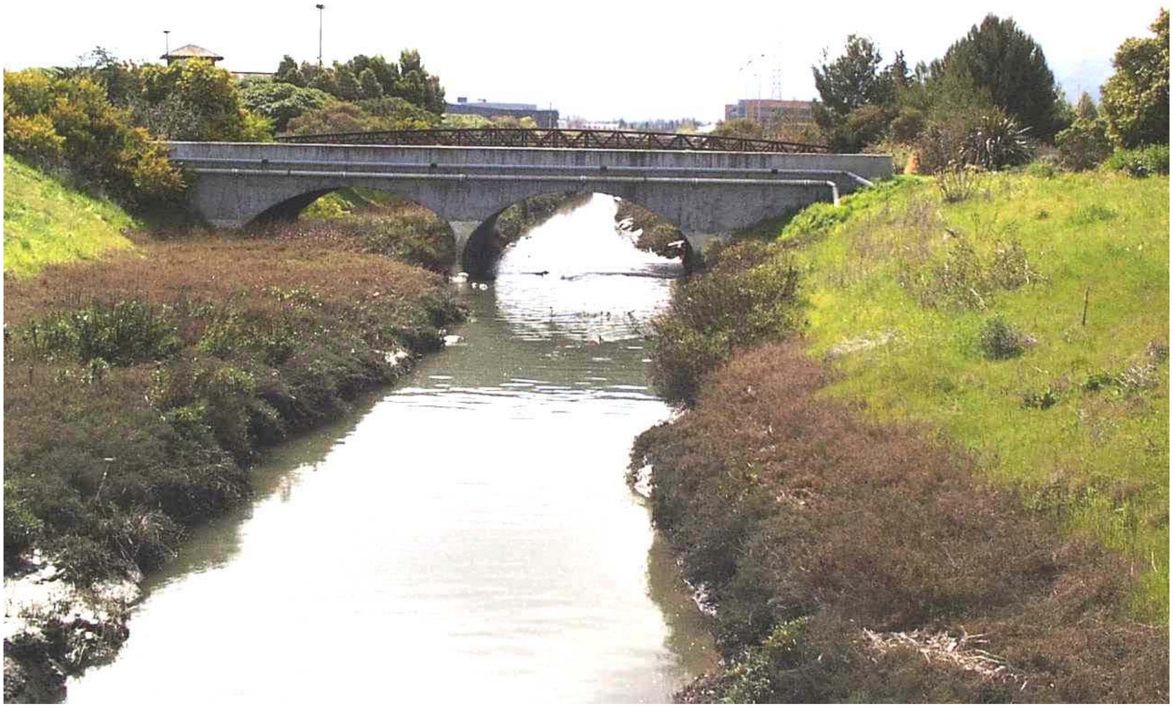
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
Salt Ponds to Boat Pond	30	1100
Boat Pond Bridge	35	1200
Boat Pond to Shoreline	148	5200
Shoreline Parkway Bridge	100	3500
Shoreline to Rengstorff	100	3500
Rengstorff Walkway Bridge	100	3500
Rengstorff to Golf Course	57	2000
Golf Course Bridge	64	2200
Golf Course to New Ditch	66	2300
New Ditch Bridge	44	1600
New Ditch to Amphitheater	43	1500
Amphitheater Parkway Bridge	131	4600
Amphitheater to Charleston	44	1600
Charleston Road Bridge	73	2600
Charleston to Hwy 101	40	1400

Reach Roughness Coefficient: Composite channel roughness varies from 0.03 to 0.056

Typical Channel Photos: See the following pages for channel descriptions and typical channel photos.

Permanente Creek

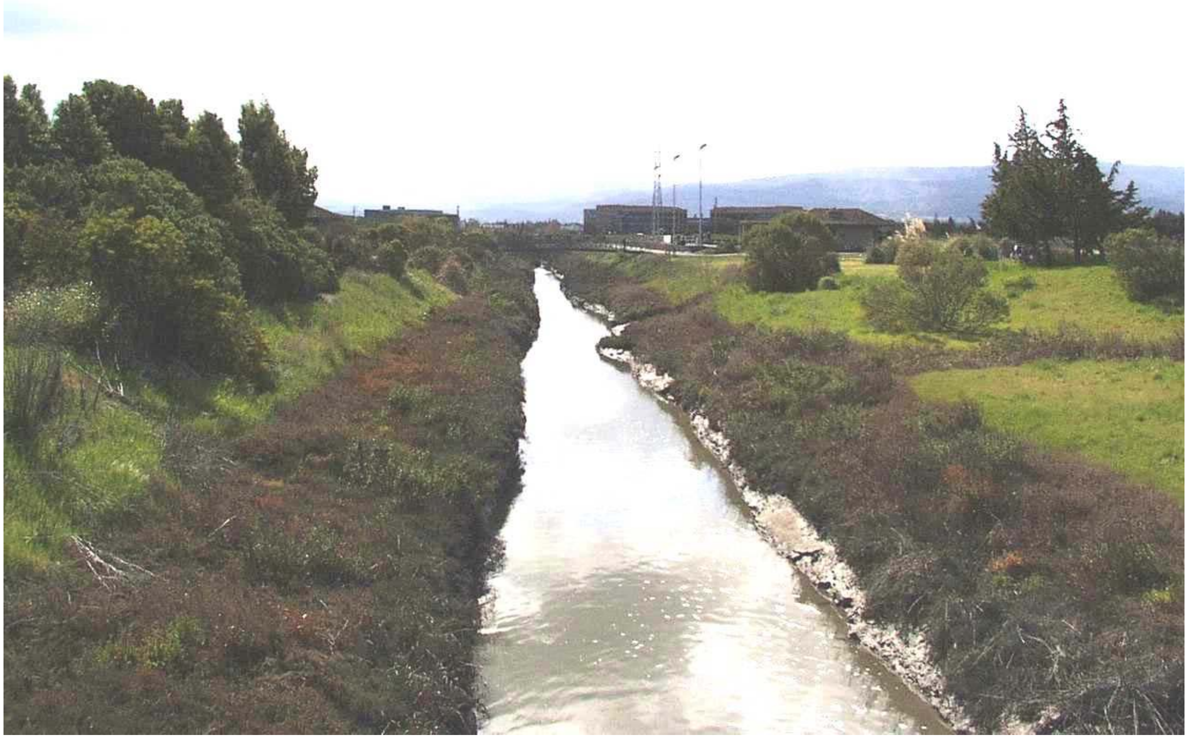


3/15/02 – Looking Upstream towards Shoreline Parkway between Boat Pond and Shoreline

Channel Description:

The channel is natural and straight. The channel shape is very broad with a tidal/ low flow channel. The vegetation varies from grasses on the upper banks to a thicker brownish grass and weeds in the lower banks with the tidal/ low flow channel clear of vegetation. Channel material consists of silt and mud.

Permanente Creek

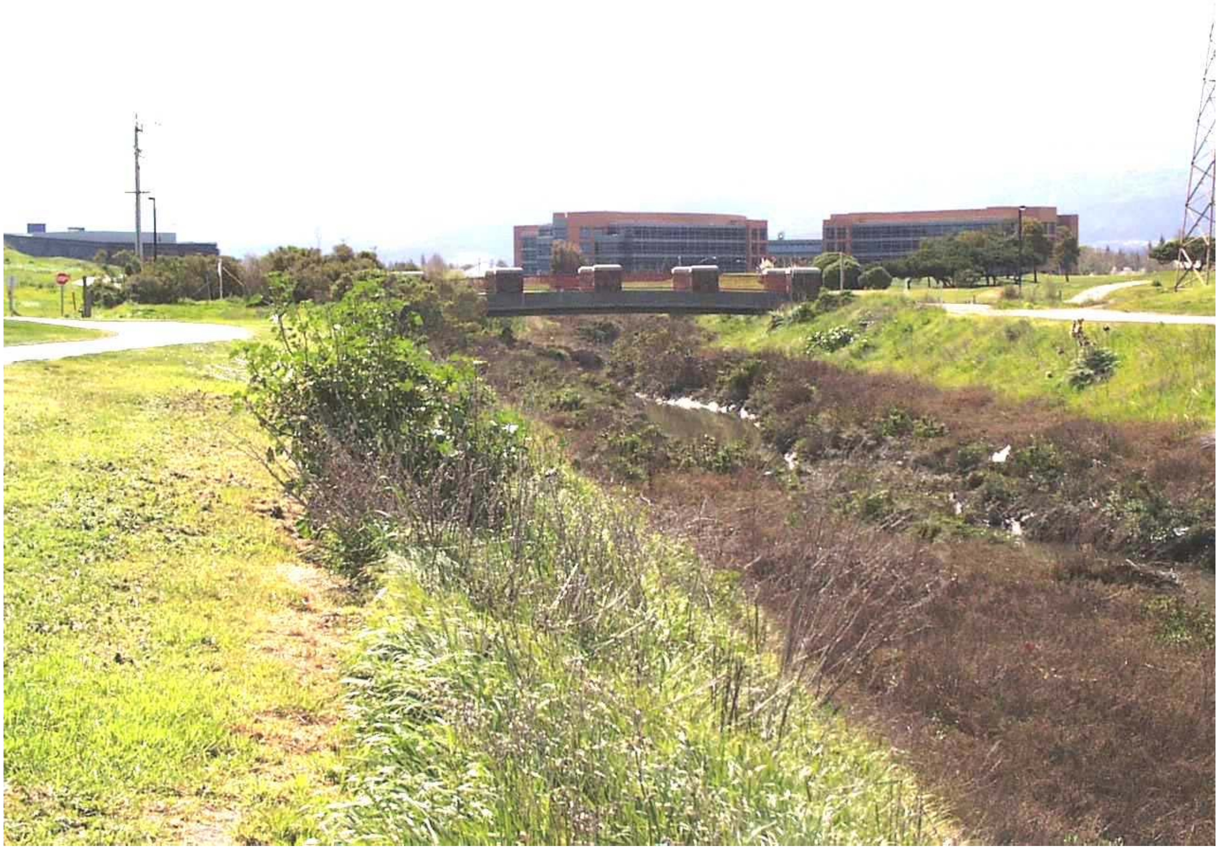


3/15/02 – Looking Upstream - between Rengstorff and Golf Course

Channel Description:

The channel is vegetated earth. The alignment is straight. The shape is broad with a tidal/ low flow channel. The vegetation varies from grass and some bushes on the upper banks to a thicker brownish grass in the lower banks with the tidal/ low flow channel clear of vegetation. Channel material consists of silt and mud.

Permanente Creek

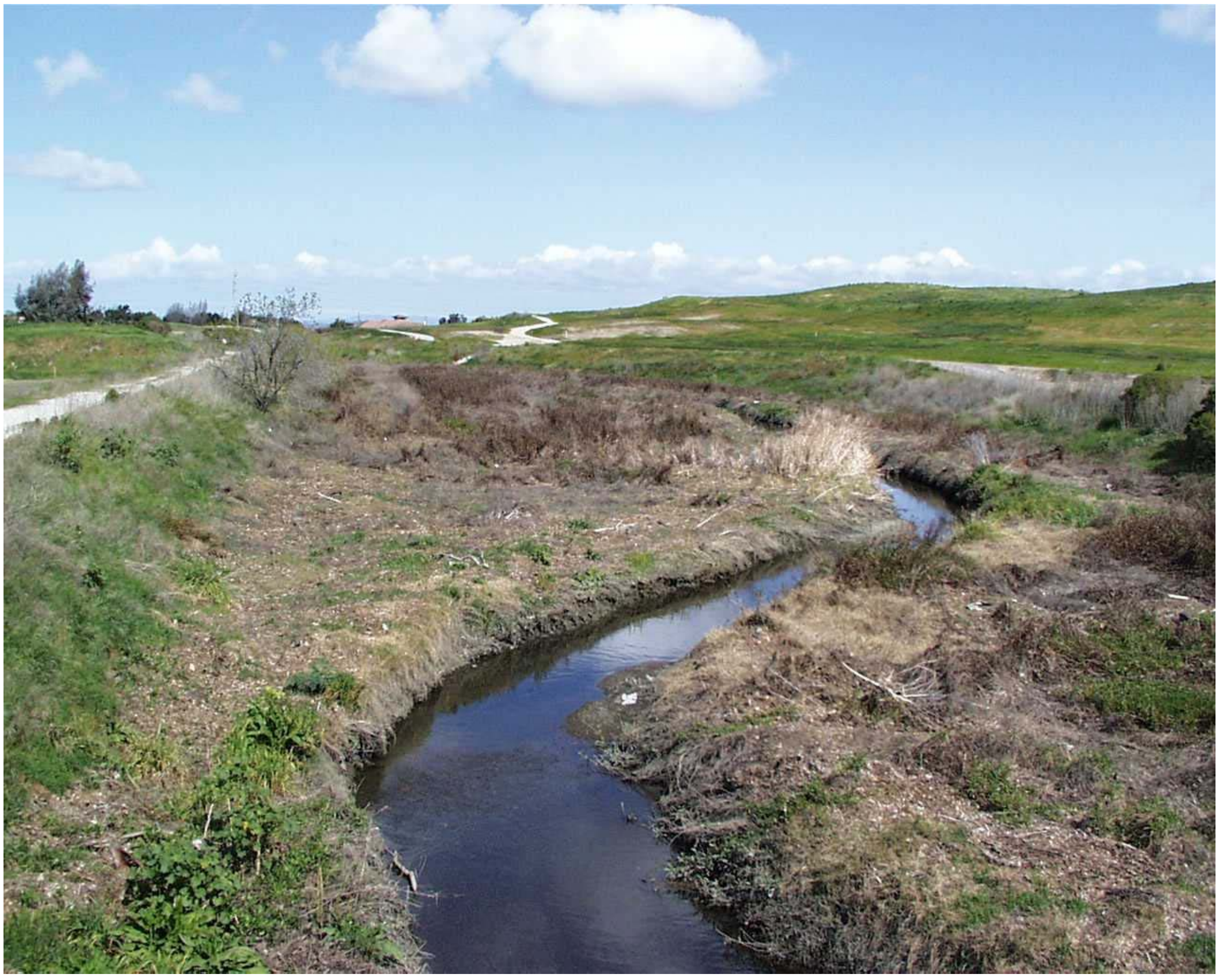


3/15/02 – Looking Upstream - Between Golf Course and New Level Ditch

Channel Description:

The earth trapezoidal shaped channel is straight with a wide invert. The tidal/ low flow channel meanders throughout invert. East and West upper banks are covered with grass while the lower banks are covered with a thicker brownish grass. Channel material mainly consists of silt and mud.

Permanente Creek

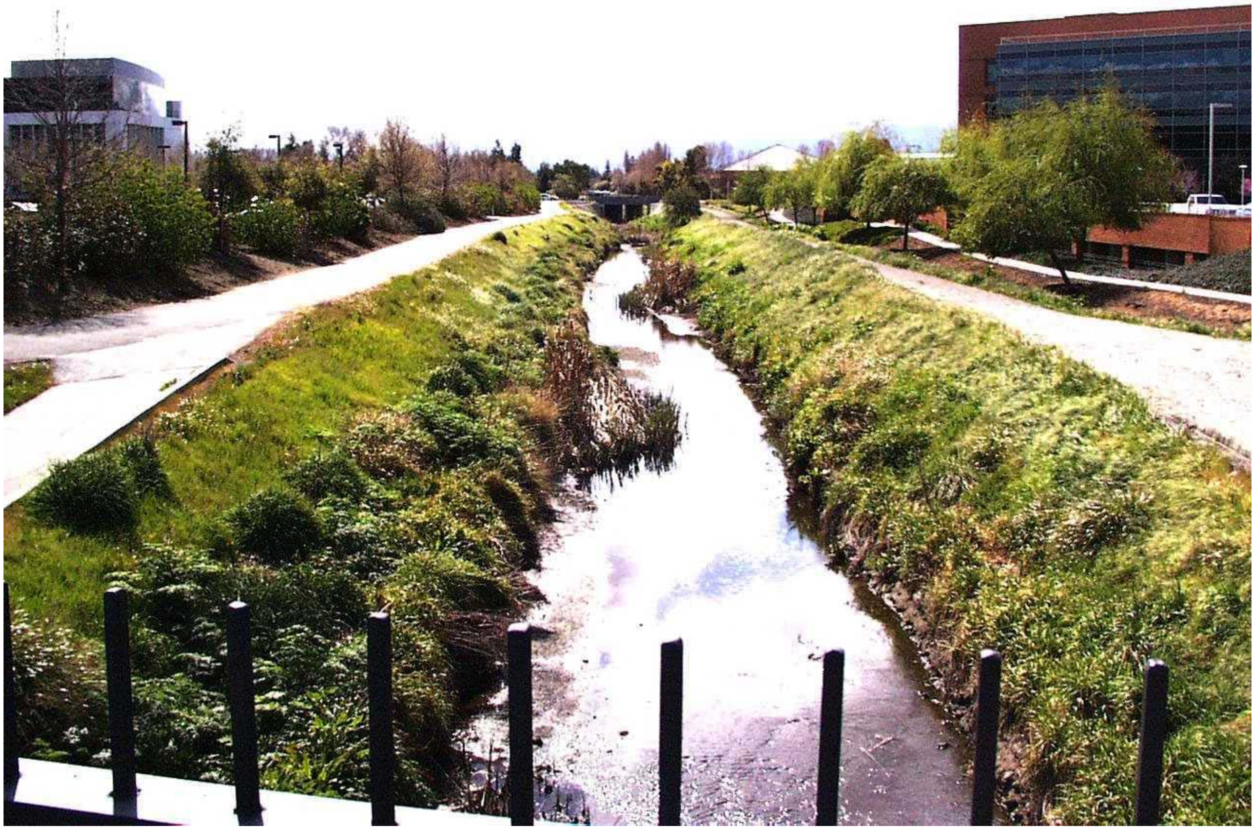


3/15/02 – Looking downstream - between New Ditch and Amphitheatre

Channel Description:

The earth trapezoidal shaped channel varies from straight to sinuous alignment with a wide invert. The tidal/ low flow channel meanders throughout the channel width. East and West upper banks are covered by grass while the lower banks are covered with a thicker, brownish grass. Channel material mainly consists of silt and mud.

Permanente Creek

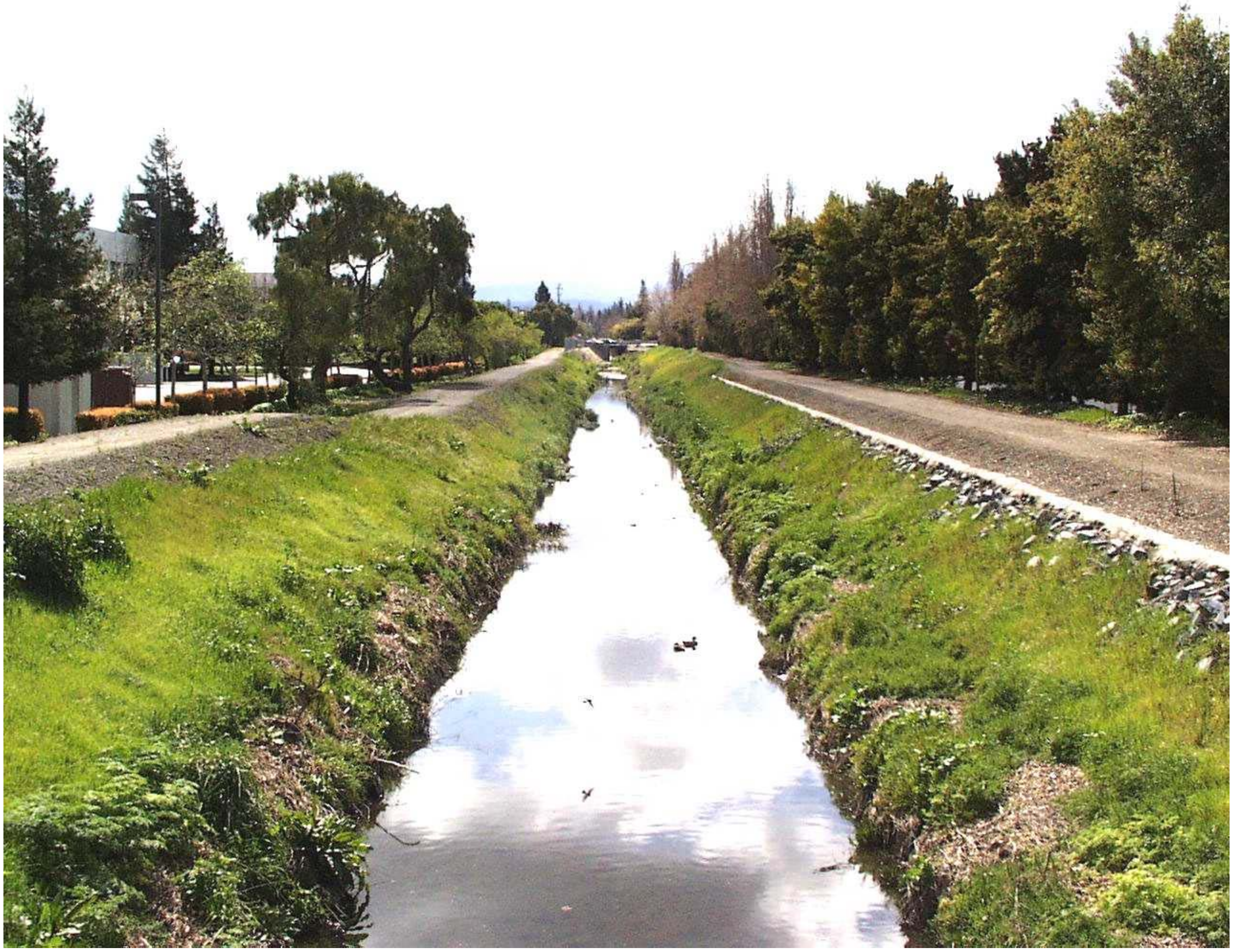


3/15/02 – Looking Upstream - between Amphitheatre and Charleston

Channel Description:

The channel is vegetated earth and has a straight alignment with a trapezoidal shape. East and West banks are covered mainly with grass. Channel material mainly consists of silt and mud.

Permanente Creek

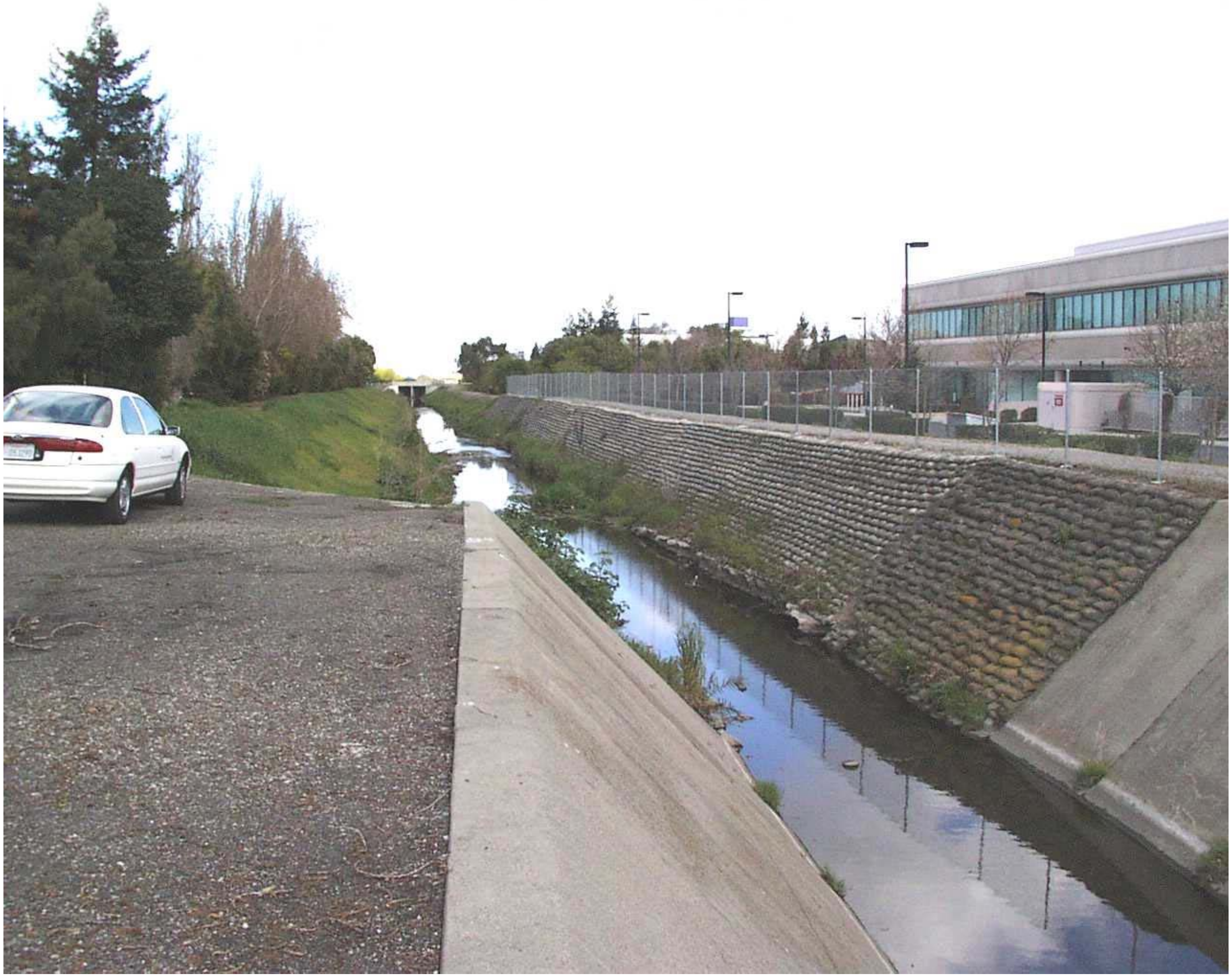


3/15/02 – Looking upstream from Charleston Road

Channel Description:

The channel is vegetated earth and vegetated rip-rap with a straight alignment and a trapezoidal shape. East and West banks are covered mainly with grass. Channel material mainly consists of silt and mud.

Permanente Creek



3/15/02 – Looking downstream from Hwy 101 towards Charleston

Channel Description:

The channel is straight with a trapezoidal shape. The West bank is vegetated earth, while the East bank consists of sacked-concrete slope protection (SCSP) with minimal vegetation. Channel material mainly consists of silt and mud.

Reach P3: Highway 101 to Villa Street (Sta 3+956 to Sta 6+106)

Reach Description: On the downstream side of Highway 101, for 58 meters the reach is a concrete trapezoidal channel. From Highway 101 upstream to Villa St, the channel is rectangular concrete (U-Frame). The channel dimensions (w x h) from Highway 101 to Central Expressway are 3.66m x 2.74m (12ft x 9ft). The channel dimensions from Central Expressway to Villa St are 3.048m x 3.048-3.5m (10ft x 10-11.5ft). There are maintenance ramps leading into the creek on the downstream sides of the Rock St, San Luis Ave, Hackett Ave, and Villa St culverts. There is a 0.56m (1.8ft) drop about 10 meters downstream of the Hetch-Hetchy Bridge.

Right-of-Way: varies
3+955 to 4+331: 17m to 19m (55ft to 62.5ft) easement
4+361 to 4+553: 13m to 15m (43ft to 50ft) easement
4+573 to 6+106: 9.5m± (31ft±) easement

Reach Slope: 0.0064 (slope measurement from sta 3+959 to sta 6+106)

1% Flow:
62 cms (2200 cfs) – at and D/S of SPRR
65 cms (2300 cfs) – at and D/S of Hwy 101

10% Flow:
31 cms (1100 cfs) – at and D/S of SPRR
34 cms (1200 cfs) – at and D/S of Hwy 101

Current Reach Capacity:

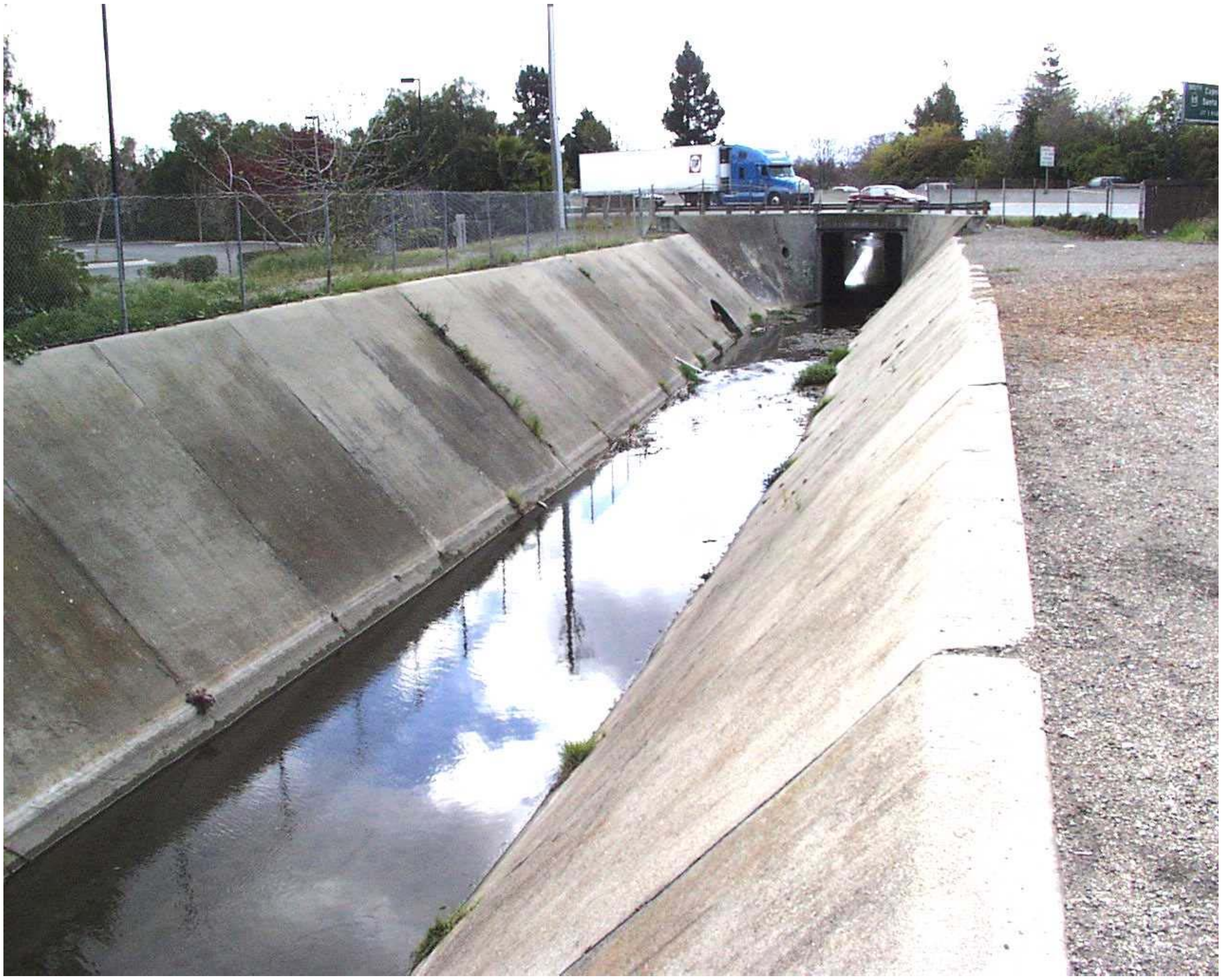
Location	Capacity (cms)	Capacity (cfs)
58m section just D/S of Hwy 101	40	1400
Highway 101 Bridge	42	1500
Hwy 101 to Old Middlefield	40	1400
Old Middlefield Way Bridge	27	950
Old Middlefield to Rock	52	1800
Rock Street Bridge	35	1200
Rock to Middlefield	58	2000
Middlefield Road Bridge	38	1300
Middlefield to San Ramon	65	2300
San Ramon Avenue Bridge	37	1300
San Ramon to San Luis	40	1400
San Luis Avenue Bridge	51	1800
San Luis to Montecito	50	1800
Montecito Avenue Bridge	43	1500
Montecito to Hackett	53	1900
Hackett Avenue Bridge	55	1900
Hackett to Hetch Hetchy	57	2000

Location	Capacity (cms)	Capacity (cfs)
Hetch-Hetchy Bridge	27	950
Hetch Hetchy to Central	31	1100
Central Expressway Bridge	33	1200
Central to SPRR	92	3200
SPRR Bridge	38	1300
SPRR to Villa	28	1000

Reach Roughness Coefficient: 0.015

Typical Channel Photos: See the following pages for channel descriptions and typical channel photos.

Permanente Creek

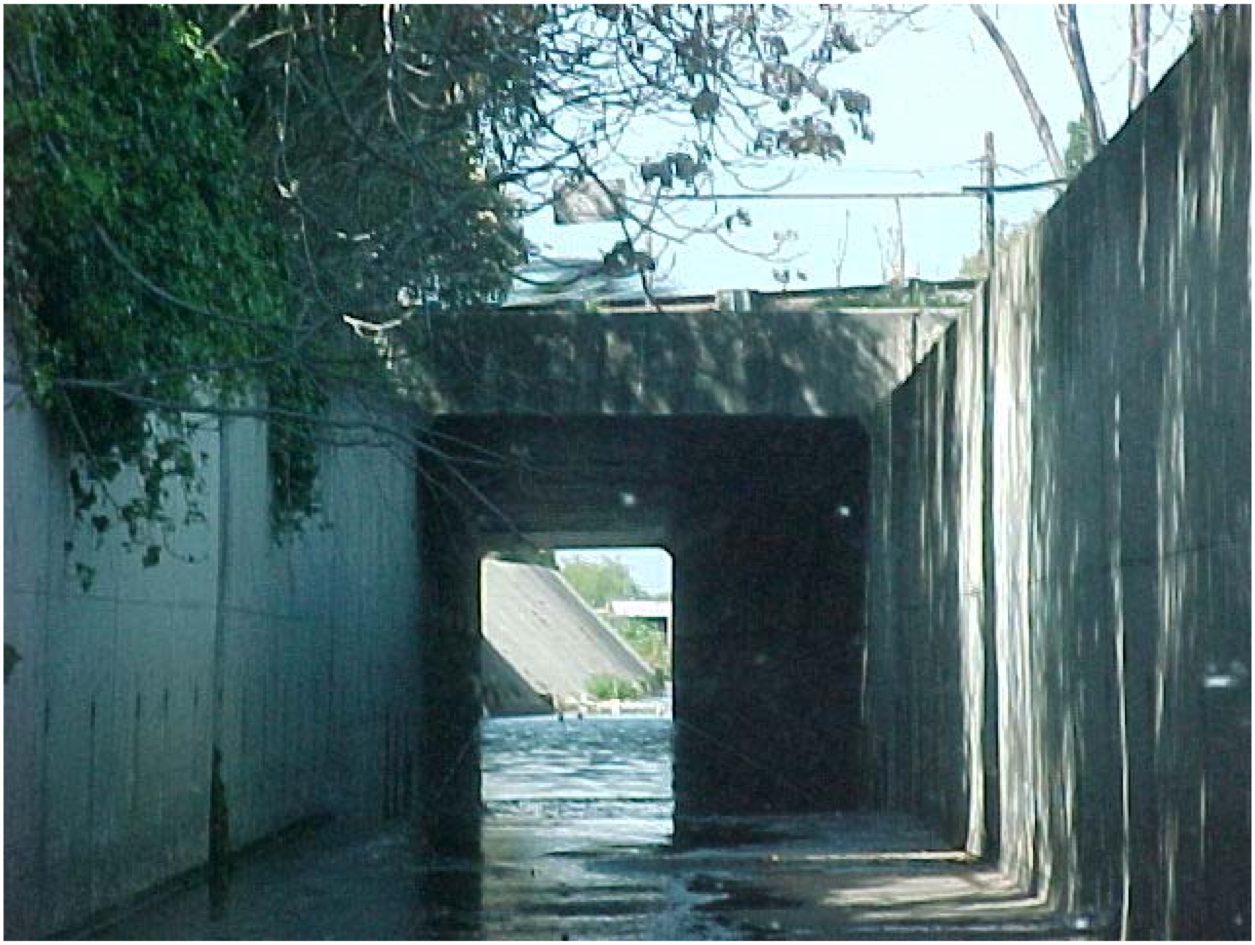


3/15/02 – Looking upstream at downstream face of Hwy 101

Channel Description:

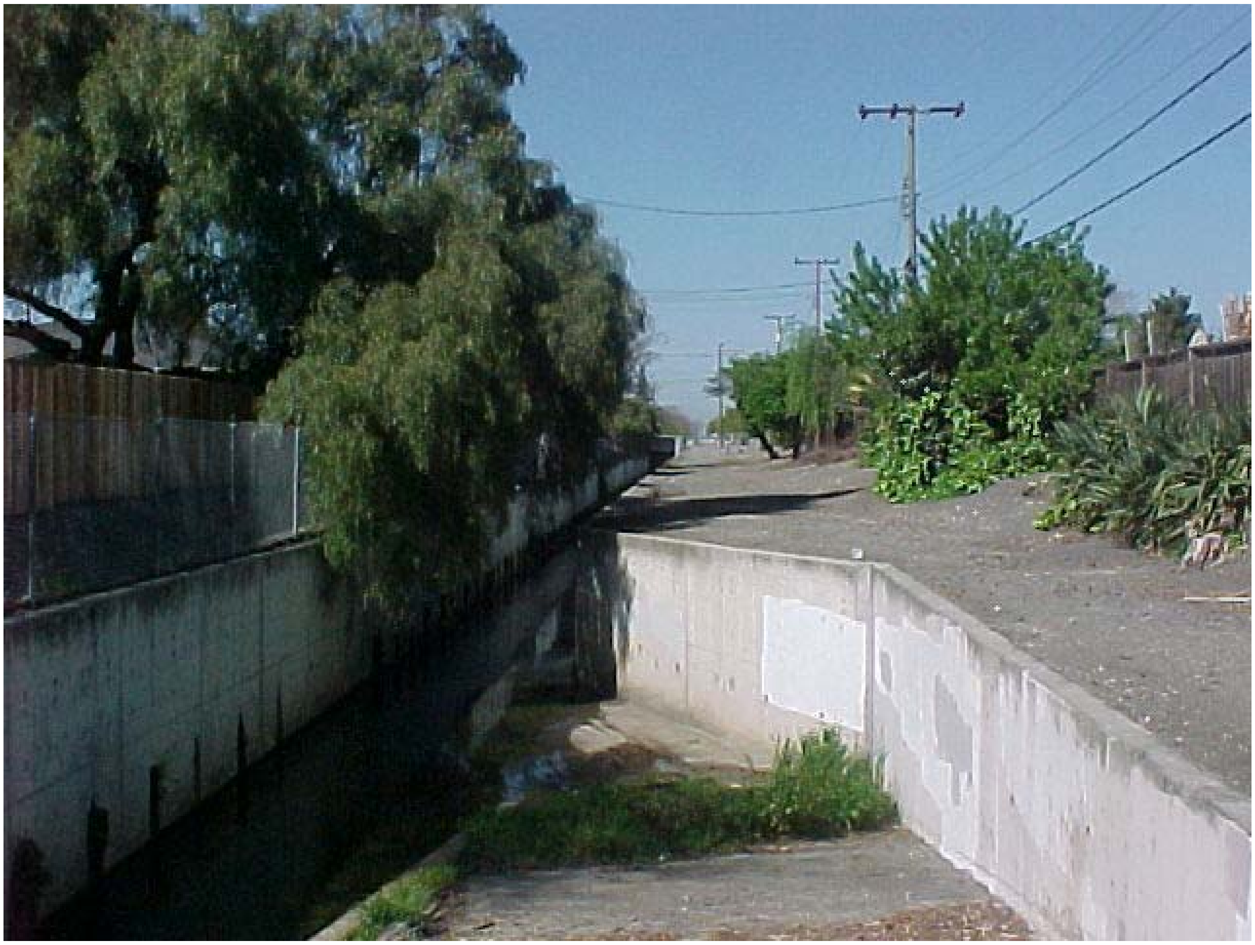
The concrete channel is straight and trapezoidal in shape. Both East and West banks are concrete in moderate condition. The channel invert is concrete and is in moderate condition.

Permanente Creek



3/28/02 – U/S face of Hwy101: between Hwy 101 and Middlefield Way Channel
Description:
The channel is a concrete U-frame with a straight alignment. Channel Dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete in moderate condition with minor abrasion, moderate vertical temperature cracks, and significant wall deflection. There is minimal vegetation or sedimentation inside the channel, such as a some ivy growing down the wall.

Permanente Creek

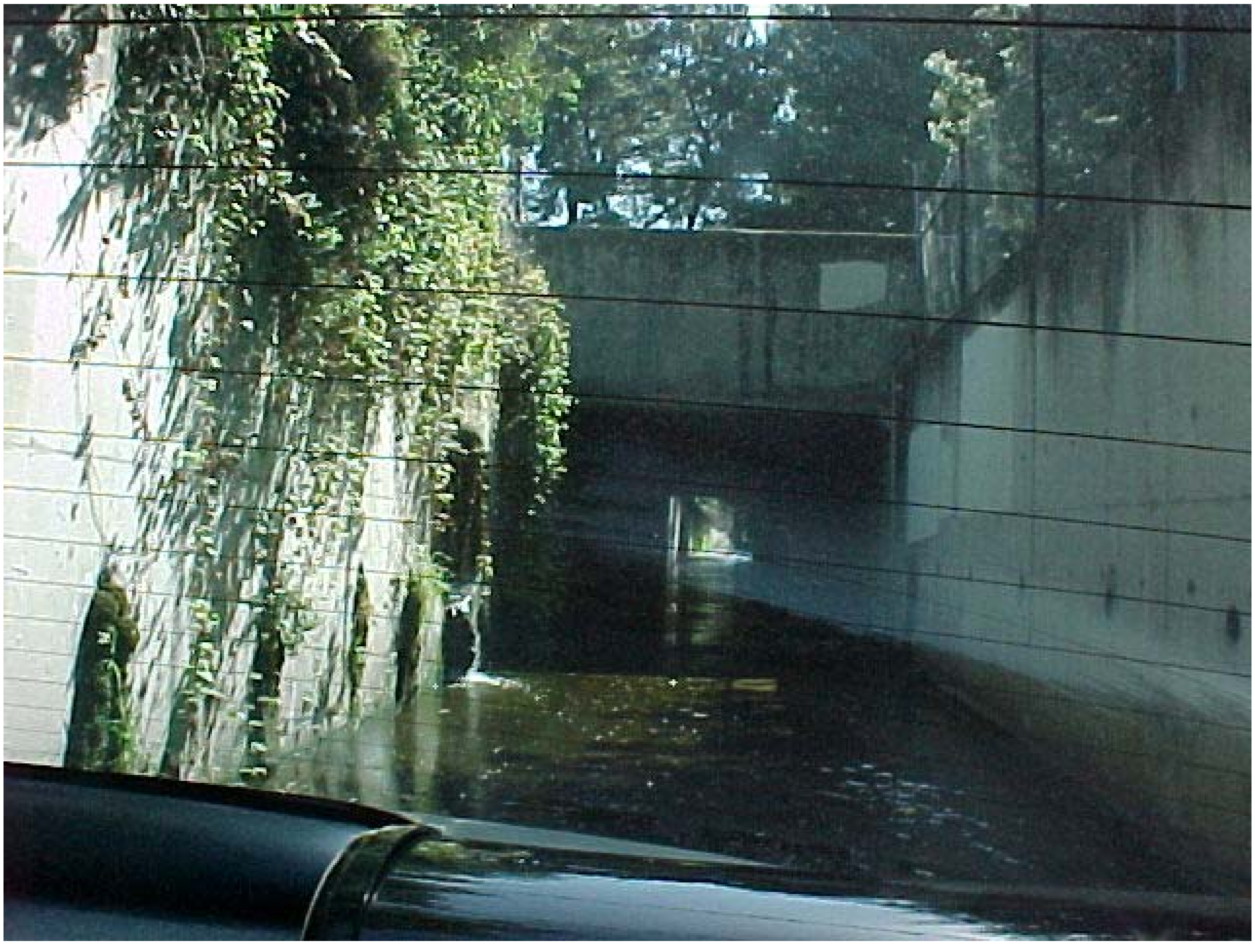


3/28/02 –Looking downstream from Rock St: between Old Middlefield Way and Rock St

Channel Description:

The channel is a concrete U-frame with a straight alignment. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with minor abrasion, moderate vertical temperature cracks, and significant wall deflection. There is no sedimentation and minimal vegetation inside the channel, such as a few trees hanging down from the top of the west bank. There is a maintenance ramp on the D/S end of Rock Street.

Permanente Creek

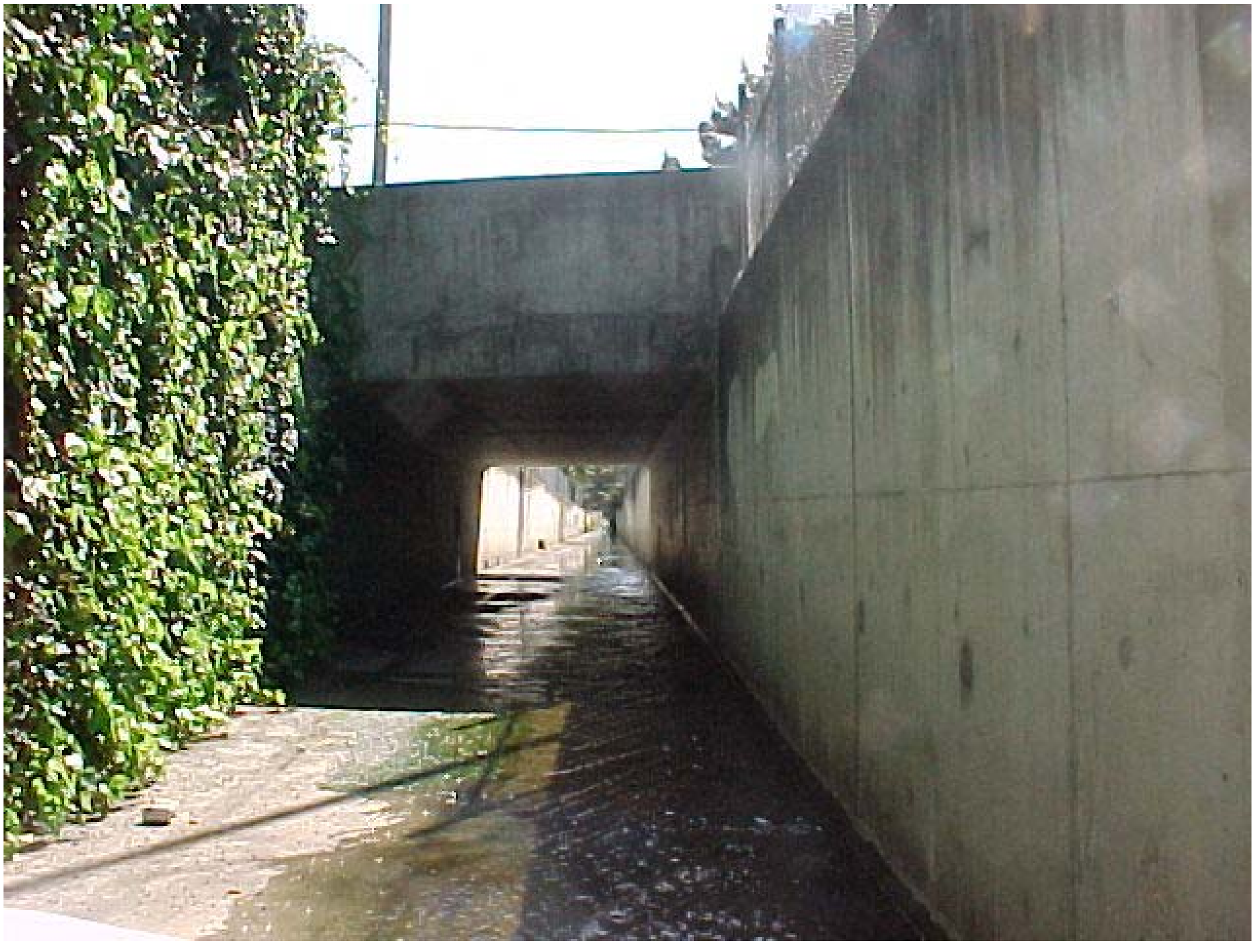


3/28/02 –Looking upstream at downstream face of Middlefield: between Rock and Middlefield

Channel Description:

The channel is a concrete U-frame with a straight alignment. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with minor abrasion, moderate vertical temperature cracks, and significant wall deflection. There is no sedimentation and minimal vegetation inside the channel, such as a few vines hanging down from the top of banks. The weep holes along some parts of the banks are clogged with mud (backfill).

Permanente Creek

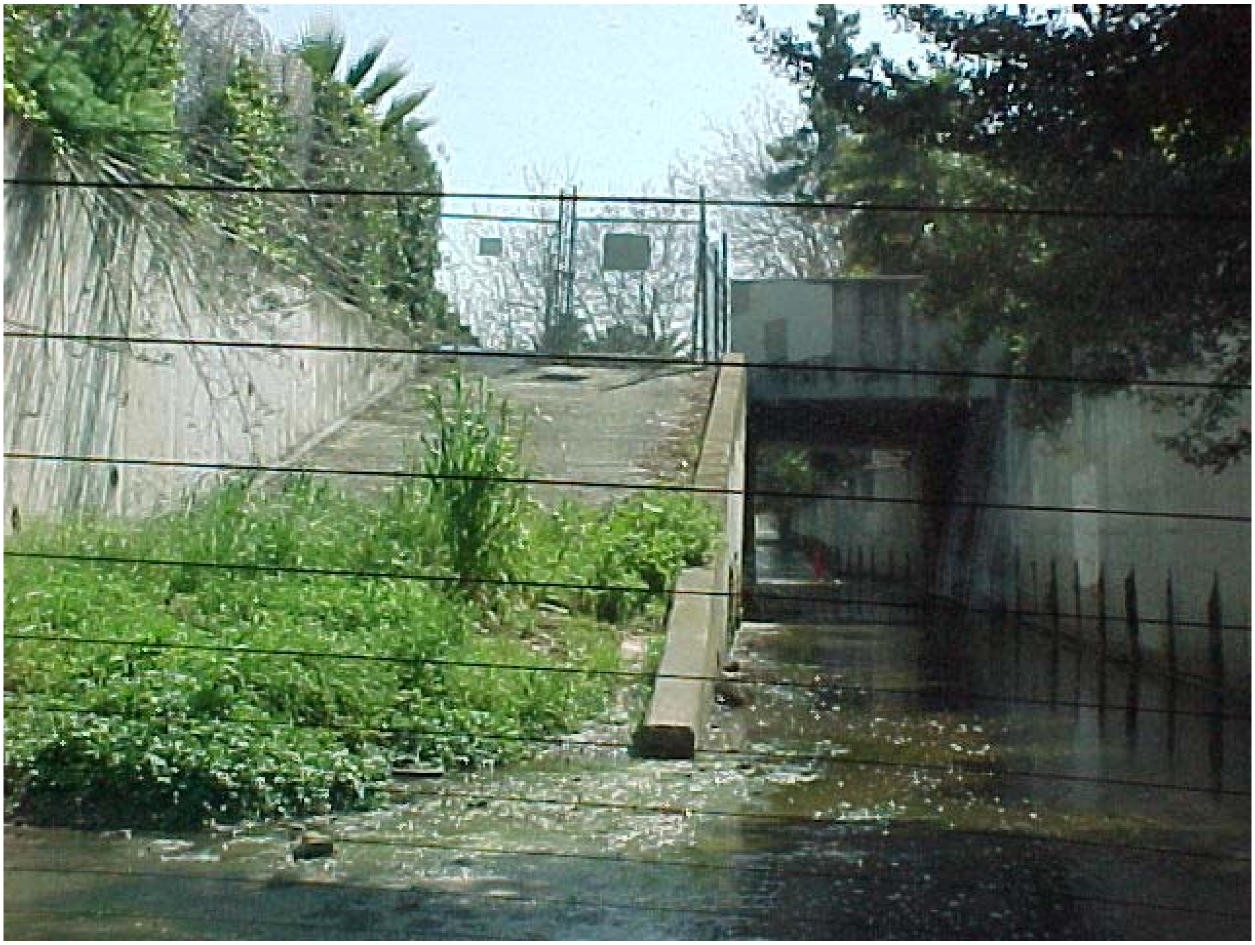


3/28/02 – Looking upstream at downstream face of San Ramon - between Middlefield and San Ramon

Channel Description:

The channel is a concrete U-frame. The alignment is generally straight. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with minor delamination, moderate vertical temperature cracks, and significant wall deflection. There is no sedimentation. Some sections have extensive vines hanging over the East bank.

Permanente Creek

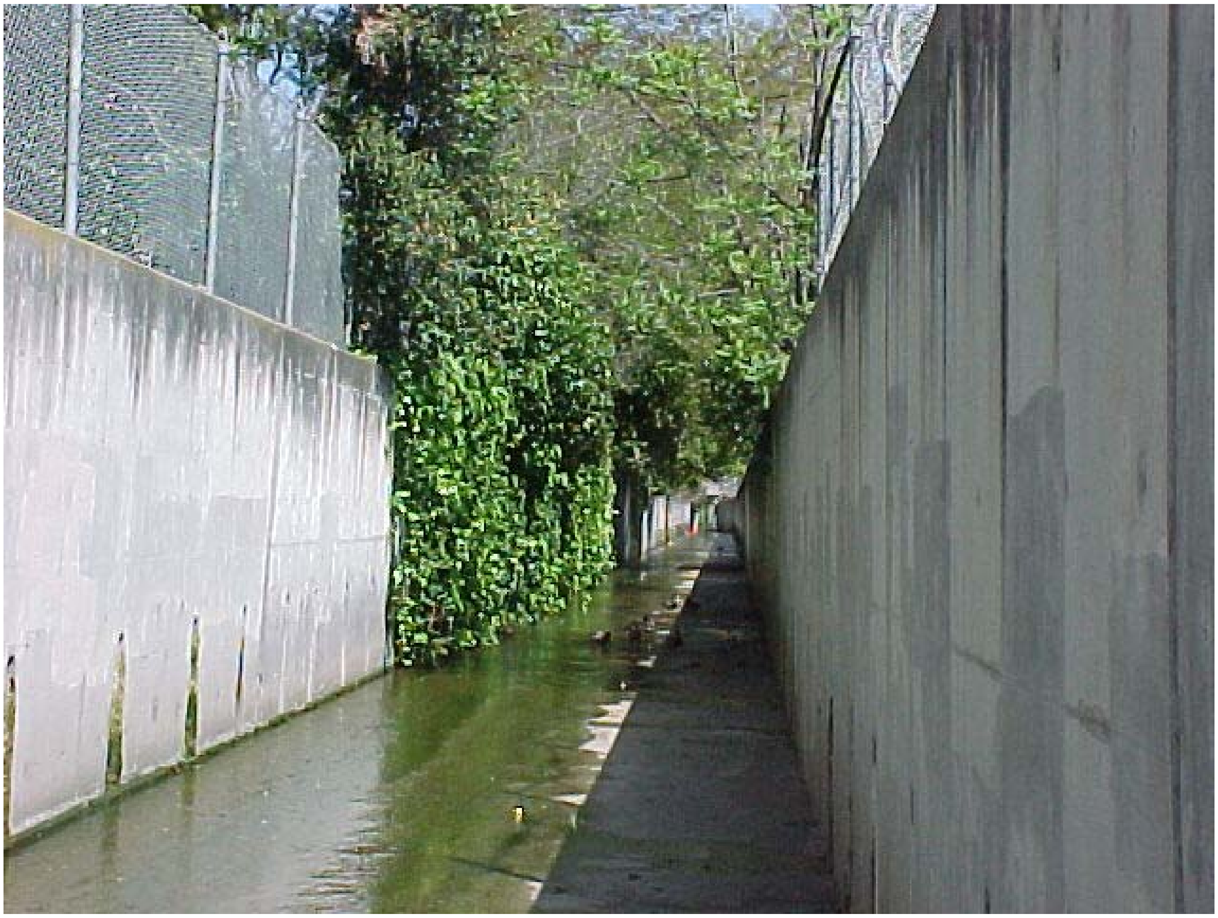


3/28/02 – Looking upstream at downstream face of San Luis - between San Ramon and San Luis

Channel Description:

The channel is a concrete U-frame with a straight alignment. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with minor abrasion, moderate vertical temperature cracks, and significant wall deflection. There is no sedimentation and the only vegetation is grass growing in the ineffective areas (maintenance ramp) and some trees overhanging from top of bank. There is a maintenance ramp on the D/S end of San Luis Ave.

Permanente Creek

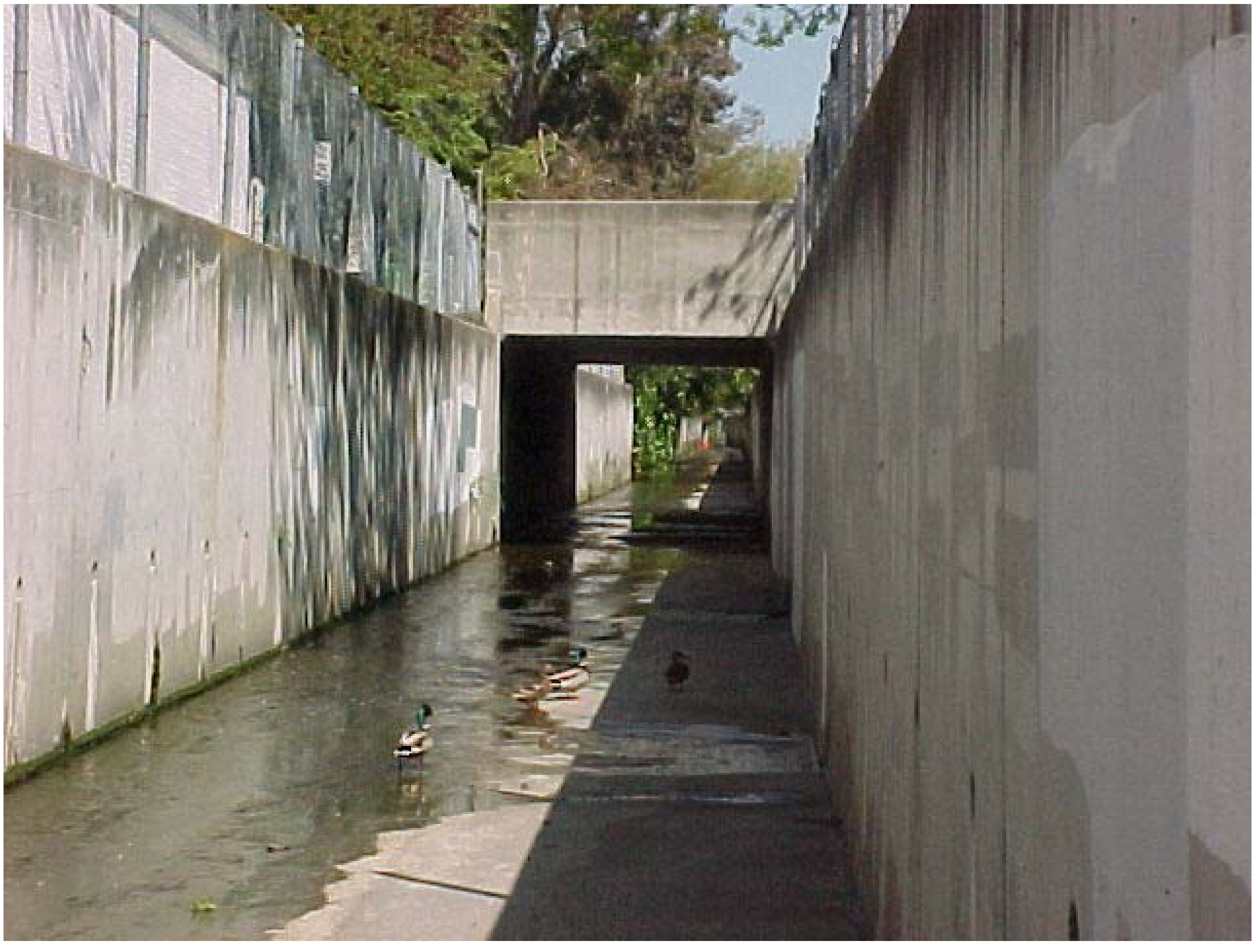


3/28/02 – Looking downstream - between San Luis and Montecito

Channel Description:

The channel is a concrete U-frame with a straight alignment. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with minor abrasion, moderate vertical temperature cracks, and very significant wall deflection. There is no sedimentation and the only vegetation is in a small section of the channel where vines are growing over the top of bank and covering a section of the West bank. Some trees are overhanging into a portion of the channel.

Permanente Creek

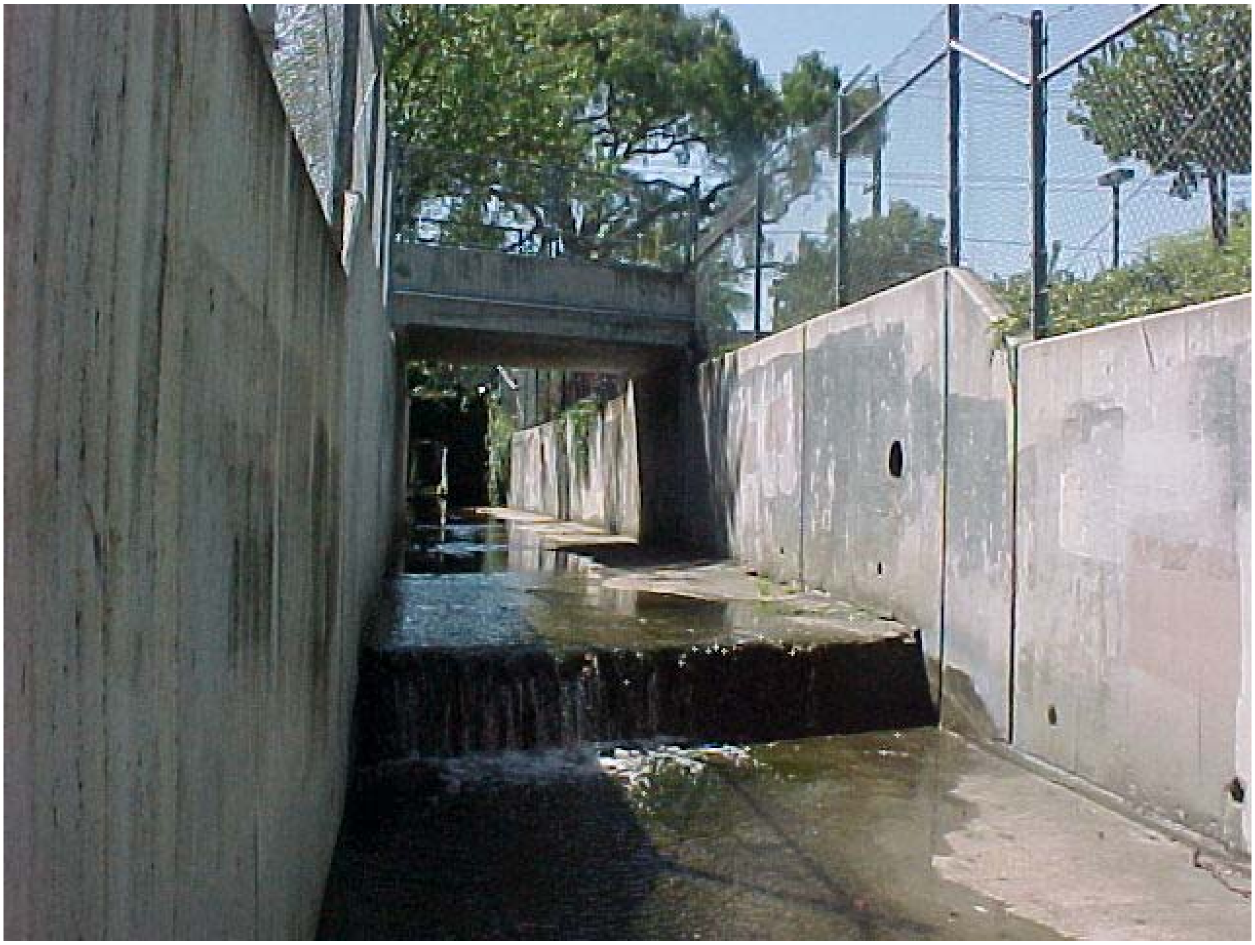


3/28/02 – Looking downstream at upstream face of Montecito - between Montecito and Hackett

Channel Description:

The channel is a concrete U-frame with a straight alignment. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with minor abrasion, moderate vertical temperature cracks, and very significant wall deflection. There is no sedimentation and no vegetation in the channel. There is a maintenance ramp on the downstream end of Hackett Ave (East bank).

Permanente Creek

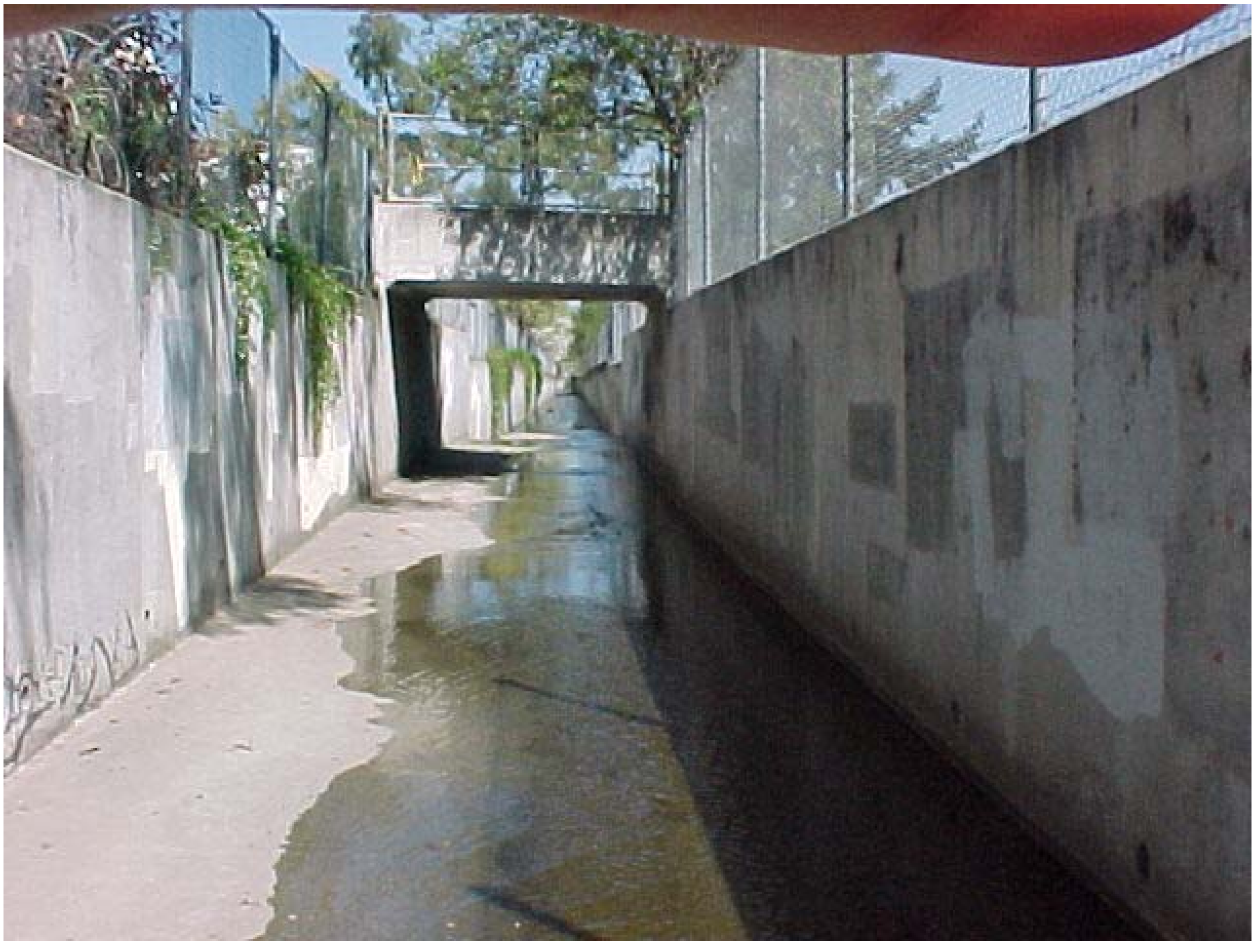


3/28/02 – Looking upstream at downstream face of Hetch-Hetchy: between Hackett Ave and Hetch-Hetchy

Channel Description:

The channel is a concrete U-frame with a straight alignment. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with minor abrasion, moderate vertical temperature cracks, moderate joint separation/crack, moderate shear crack, exposed rebar moderate, and very significant wall deflection. There is no sedimentation and no vegetation in the channel. There is a 0.56m drop just downstream of Hetch-Hetchy Bridge.

Permanente Creek

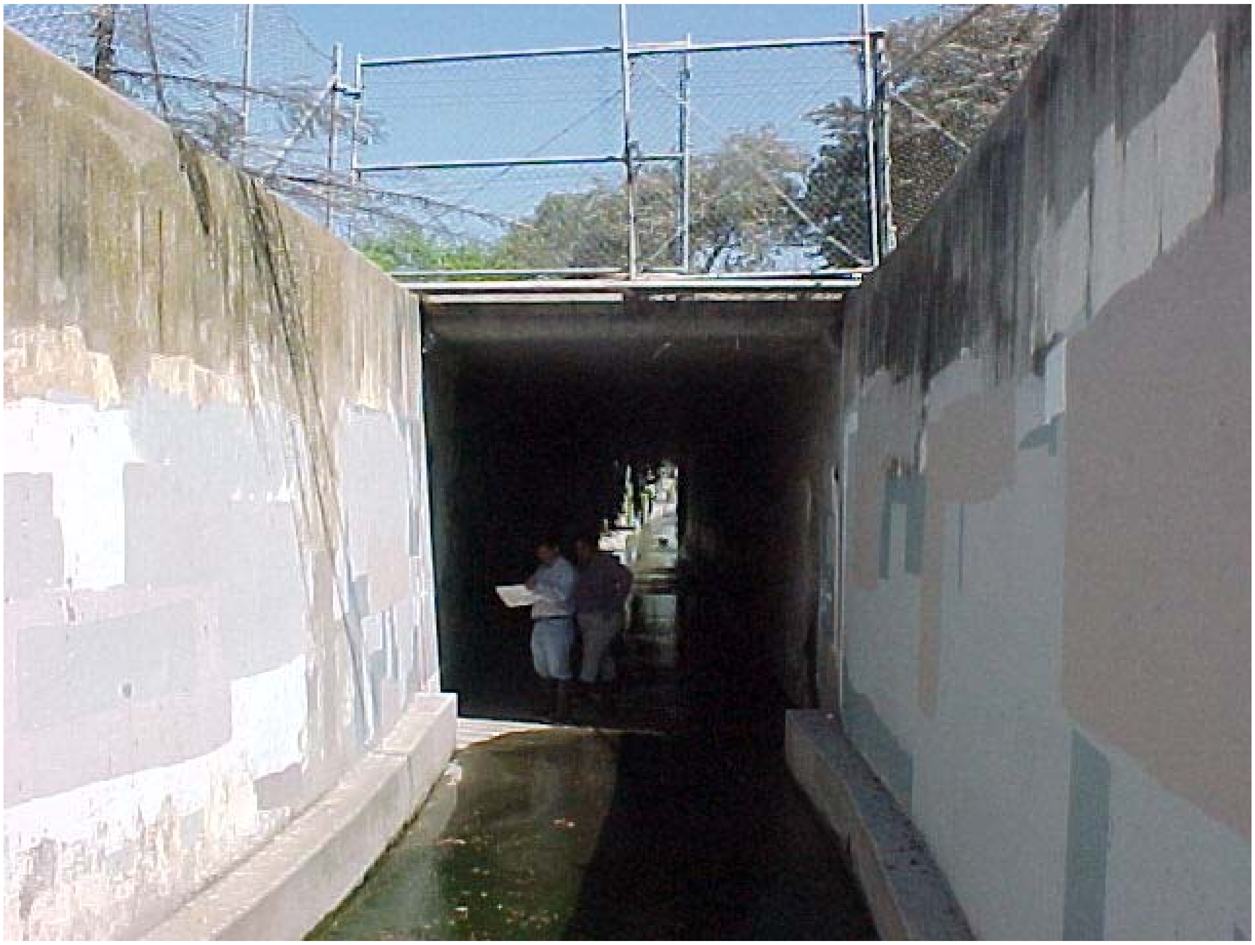


3/28/02 – Looking downstream at Hetch Hetchy - Between Hetch Hetchy and Central Expwy

Channel Description:

The channel is a concrete U-frame with a straight alignment. Channel dimensions (w x h) are 3.66m x 2.74m. The banks and invert are concrete and are in moderate condition with moderate vertical temperature cracks, moderate shear cracks, and very significant wall deflection. There is no sedimentation and no vegetation in the channel.

Permanente Creek

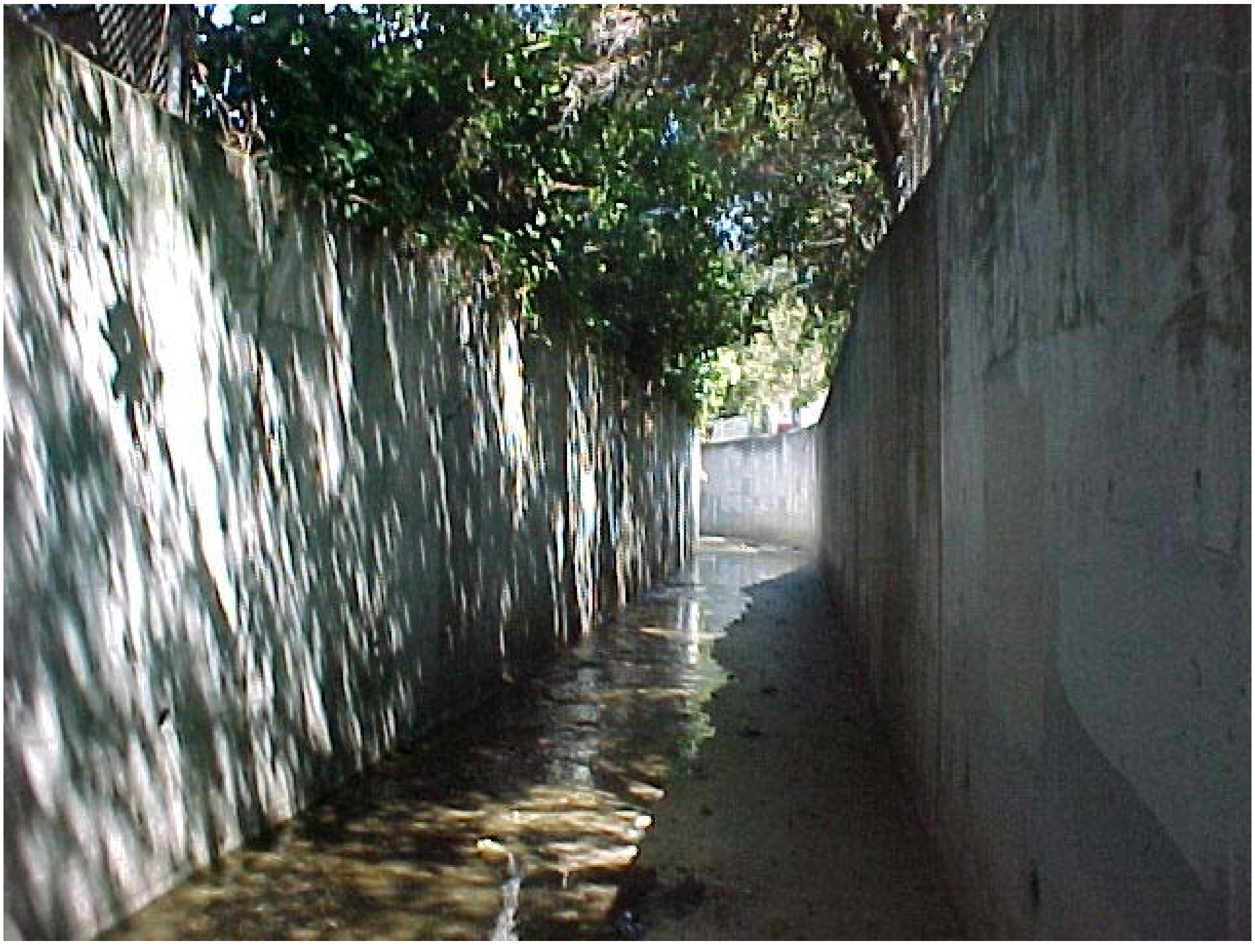


3/28/02 – Looking downstream at upstream face of Central Expwy - Between Central Expwy and SPRR

Channel Description:

The channel is a concrete U-frame with a straight alignment (curved slightly). Channel dimensions (w x h) are 3.048m x 3.048-3.50m. The banks and invert are concrete and are in moderate condition. There is no sedimentation and no vegetation in the channel.

Permanente Creek



3/28/02 – Looking downstream - between SPRR and Villa St
Channel Description:
The channel is a concrete U-frame with a mostly straight alignment. Channel dimensions (w X h) are 3.048m x 3.048-3.50m. The banks and invert are concrete and are in moderate condition with moderate vertical temperature cracks, moderate shear crack, and very significant wall deflection. There is no sedimentation and no vegetation in the channel. There is a maintenance ramp on the downstream end of Villa St. (West bank).

***Reach P4*:** Villa St to El Camino Real (Sta 6+106 to Sta 7+223)

Reach Description:
The reach consists of two underground culverts separated by a 54-meter long concrete trapezoidal section. The Villa St. culvert is about 270 meters long and extends from the downstream end of Villa St. to about 55 meters downstream of California St. The El Camino/California culvert is about 795 meters long and extends from the downstream end of California St. to about 60 meters upstream of El Camino Real. There is a maintenance ramp on the downstream side of Villa St. There are two drop structures along this reach. One is located at the downstream end of the El Camino/California culvert; the other is located within the same culvert underneath Latham St.

Right-of-Way: 8.5m to 9m (28ft to 30 ft) fee and easement

Reach Slope: 0.0095 (slope measurement from 6+106 to 7+223)

1% Flow: 57 cms (2000 cfs)

10% Flow: 27 cms (960 cfs)

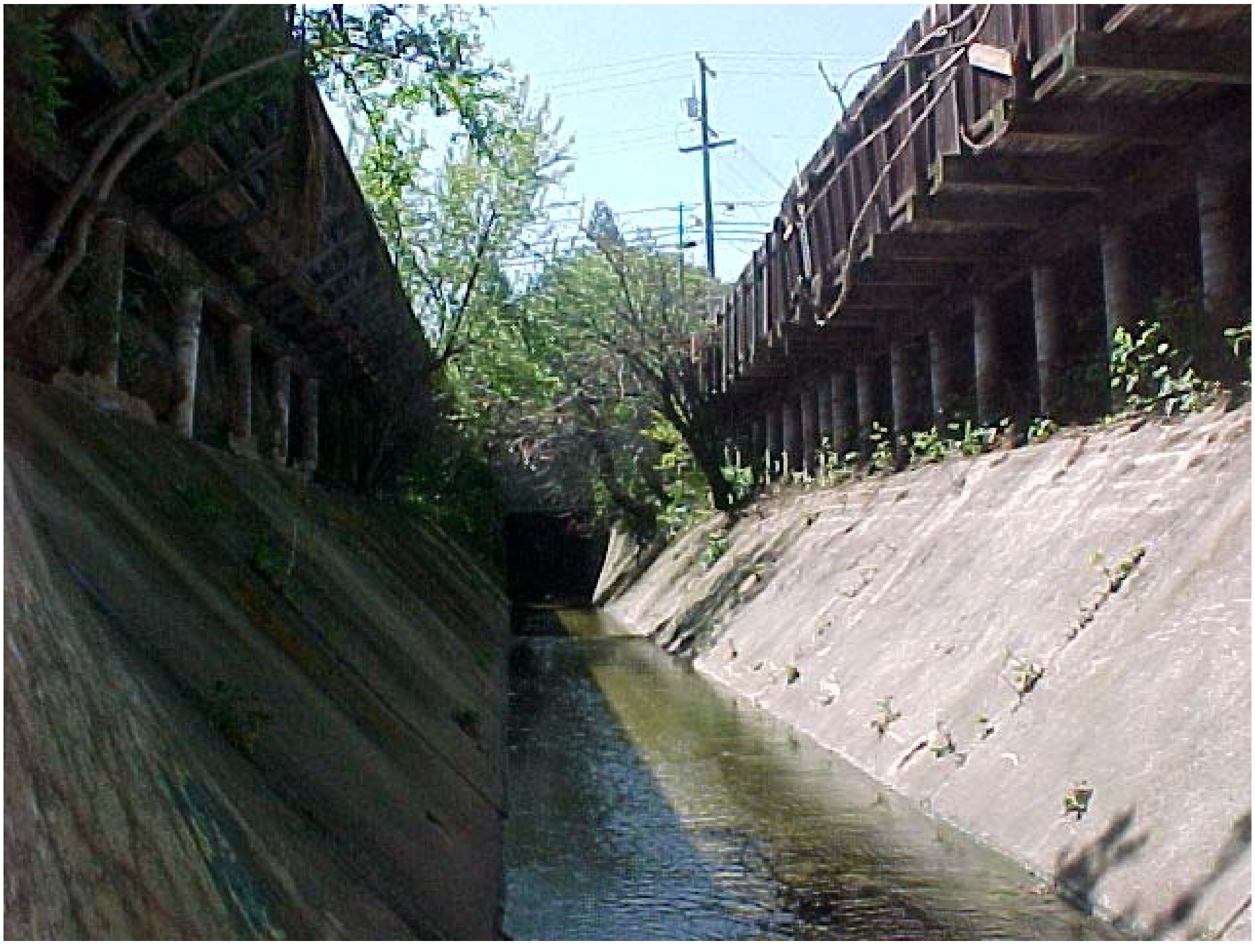
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
Villa Street Culvert	34	1200
Villa Street Culvert to El Camino Culvert	34	1200
El Camino Real Culvert	34	1200

Reach Roughness Coefficient: 0.015

Typical Channel Photos: See the following page for typical photo for the reach between the two culverts. Culvert photos are not shown.

Permanente Creek



3/28/02 – Looking Upstream - between Villa St. culvert and California/El Camino culvert

Channel Description:

The channel is a concrete trapezoid with a straight alignment. The channel invert is 2.44m wide with the banks at 1:1 slopes. The banks and invert are concrete and are in moderate condition. Near the upstream end there is some vegetation along the top of banks. Along the top of both banks, the properties are elevated approximately 3m above the banks on piers (see photo).

Reach P5: El Camino Real to the Hale Creek Confluence (Sta 7+223 to Sta 8+007)

Reach Description:
The majority of the channel is a concrete U-Frame with w x h dimensions of 3.66m x 2.13-3.048m (12ft x 7-10ft). At the Hale Creek confluence, the channel changes to a concrete trapezoid. There is a maintenance ramp at the downstream end of the Mountain View Bridge. There are two sloped drops along this reach, one just upstream of the El Camino Real culvert and another just upstream of the Park Ave. Bridge.

Right-of-Way: 4.7m to 15m (15.5ft to 50ft) fee and easement

Reach Slope: 0.0069 (slope measurement from sta 7+223 to sta 8+013)

1% Flow: 57 cms (2000 cfs)

10% Flow: 27 cms (960 cfs)

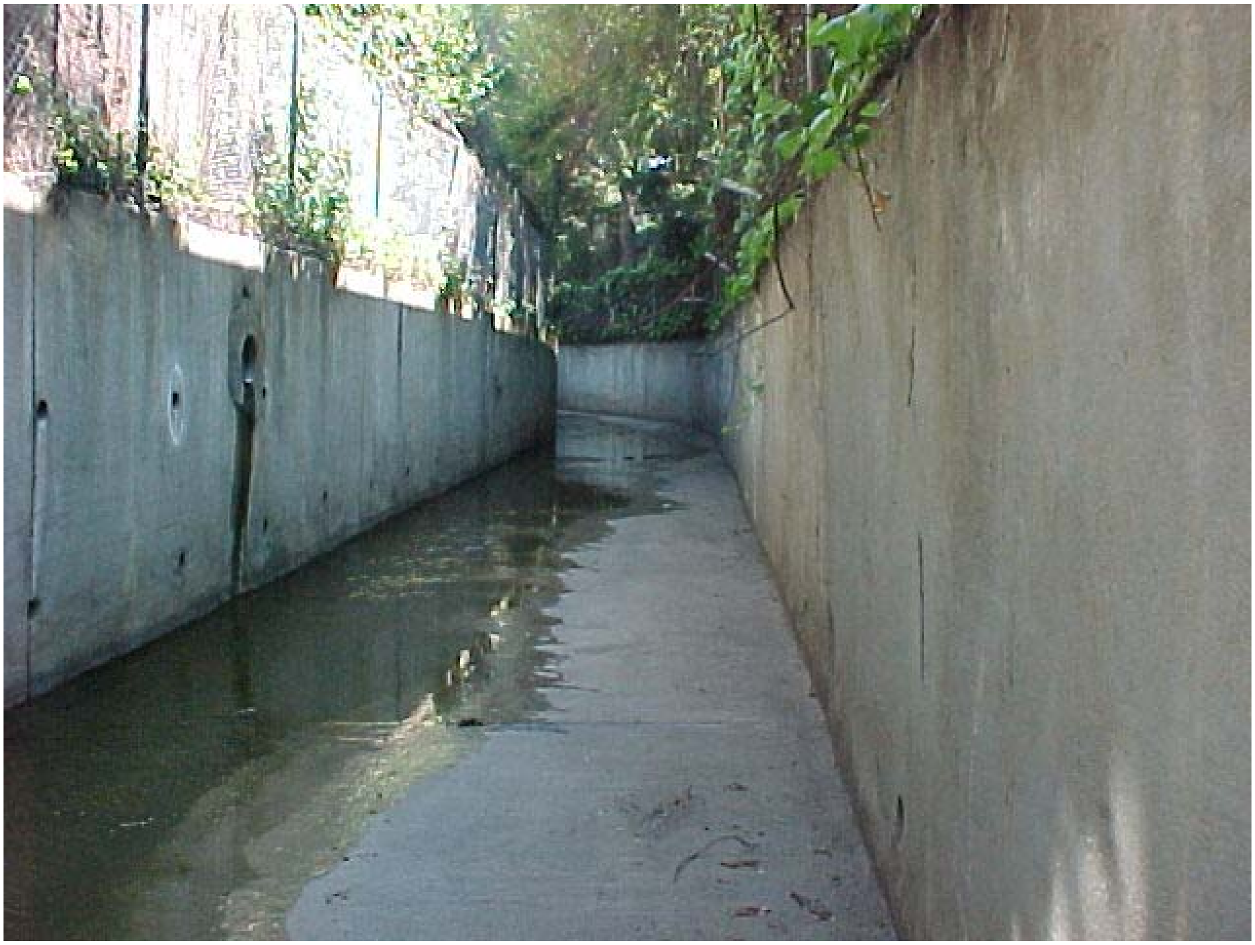
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
El Camino Real to Private Bridge	36	1300
Private Bridge	36	1300
Private Bridge to Park Drive	36	1300
Park Drive Bridge	28	1000
Park Drive to Mountain View Ave	18	650
Mountain View Ave Bridge	21	750
Mountain View Ave to Hale Creek Confluence	18	650

Reach Roughness Coefficient: 0.015

Typical Channel Photos: See the following pages for channel descriptions and typical channel photos.

Permanente Creek

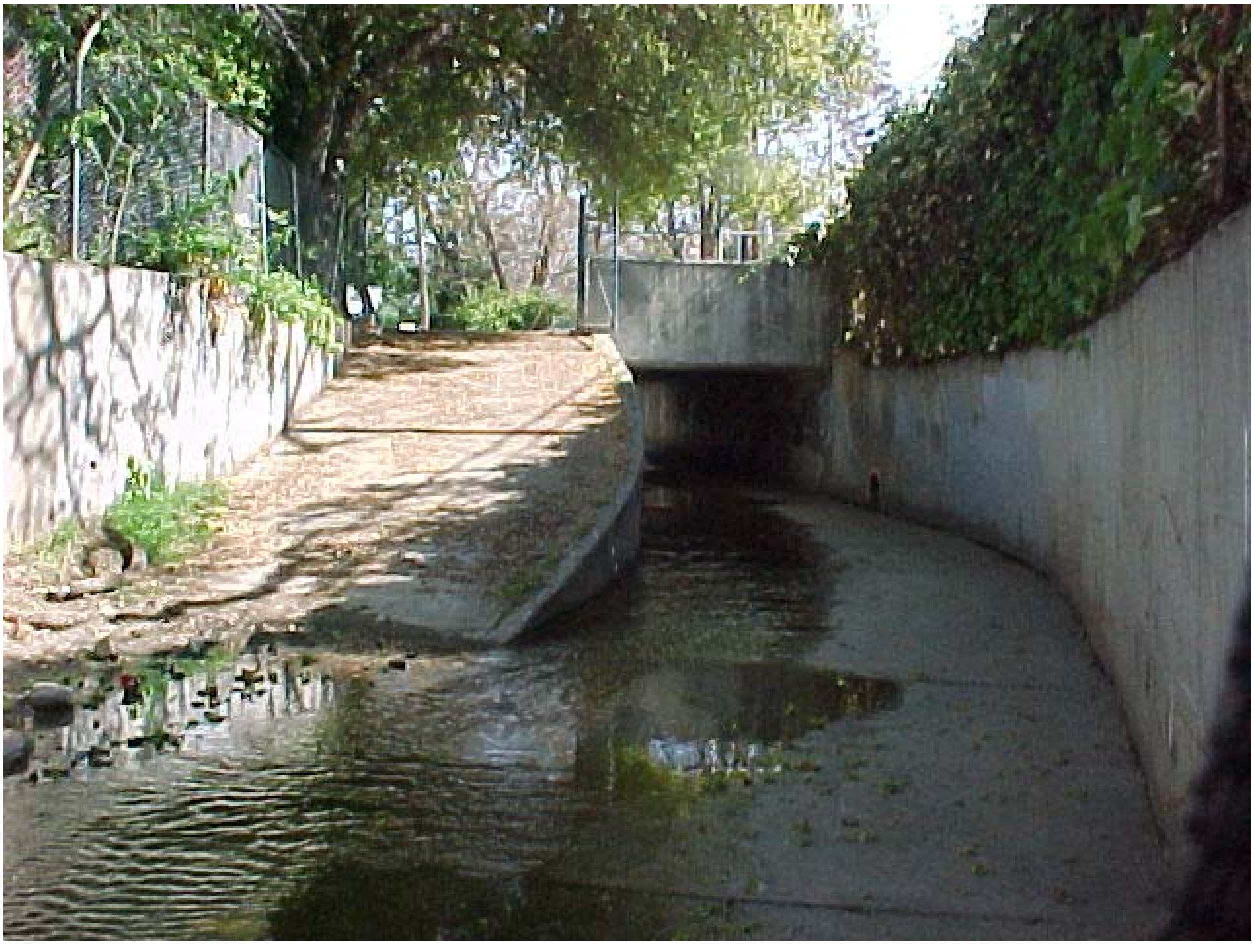


3/26/02 – Looking upstream - Between El Camino Real and Park Drive

Channel Description:

The channel is a concrete U-frame with two curved bends in the alignment. Channel dimensions (w x h) are 3.66m x 2.13-3.048m. The banks and invert are concrete and are in moderate condition with moderate vertical temperature cracks, moderate efflorescence at joints of segment, and severe wall deflection. All along the channel there are fences at the edges of the top of banks with vegetation behind them. There is no vegetation or sedimentation in the channel.

Permanente Creek



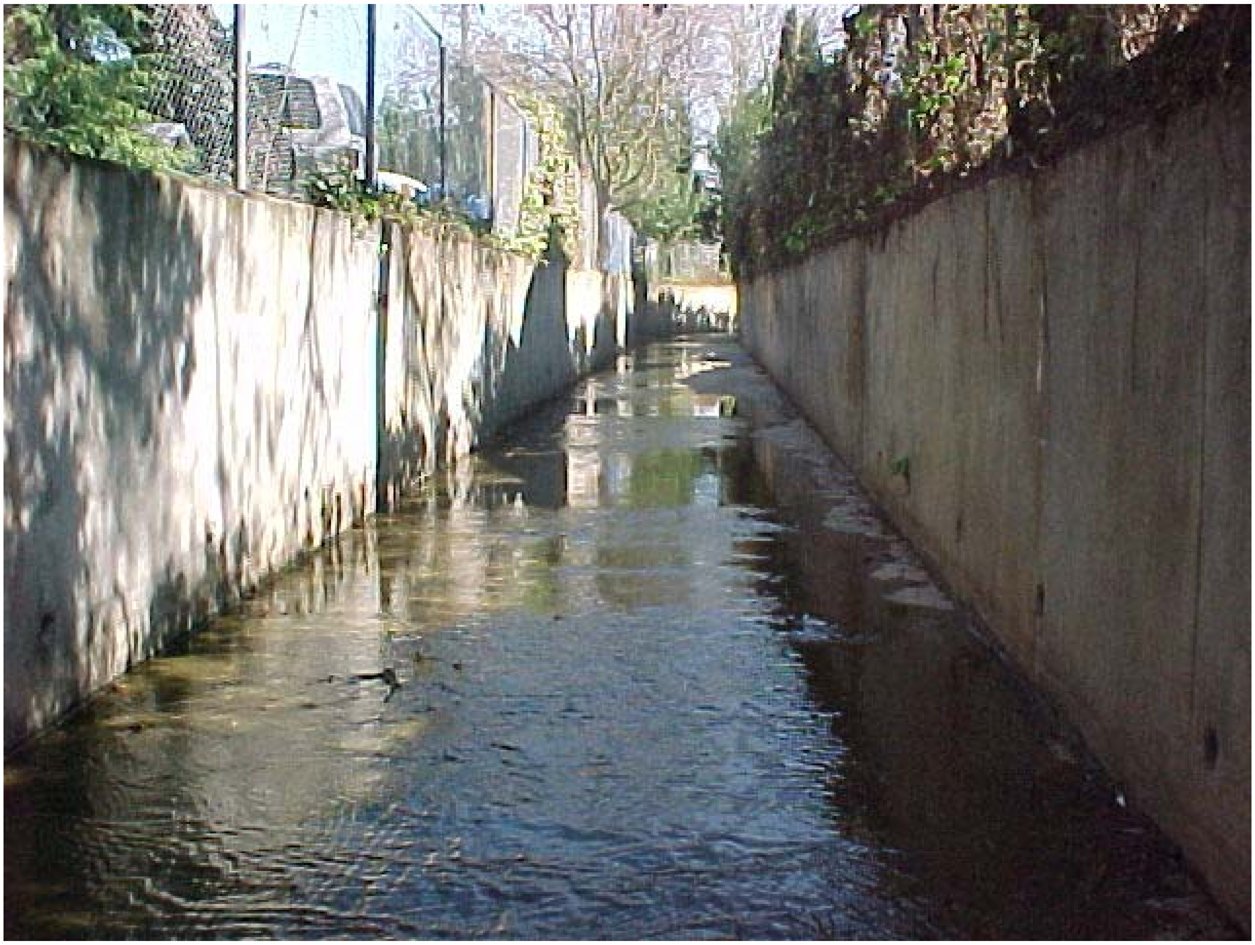
3/26/02 – Looking upstream at downstream face of Mountain View Ave. - Between Park and Mountain View Ave.

Channel Description:

The channel is a concrete U-frame with a few curved bends in the alignment. Channel dimensions (w x h) are 3.66m x 2.13-3.048m. The banks and invert are concrete and are in moderate condition with moderate vertical temperature cracks and severe wall deflection All along the channel there are fences at the edges of the top of banks with properties coming up to the fence. There is no vegetation or sedimentation in the channel. There is a maintenance ramp on the downstream end of Mountain View Ave. (East bank).

Note: Several channel sections in this reach have been repaired in the past five years.

Permanente Creek



3/26/02 – Looking upstream - Between Mountain View Ave. and Hale Creek Confluence

Channel Description:

The channel is a concrete U-frame with a few big bends in the alignment. The banks and invert are concrete and are in moderate condition with minor pattern cracking, minor to moderate exposed rebar, minor to moderate abrasion, minor to moderate popouts, moderate cavitation, moderate vertical temperature cracks, and severe wall deflection. There is no vegetation or sedimentation in the channel.

Reach P6: Hale Creek Confluence to Cuesta/Miramonte Ave (Sta 8+007 to Sta 9+100)

Reach Description:
The channel is natural and small throughout most of this reach, with some sections of sacked concrete (SCSP), shotcrete, and stacked concrete walls. The vegetation varies from mature trees and grass to no vegetation at all (bare earth). It is difficult to access this reach, but there are access gates (no ramps) at Barbara Ave., Marilyn Drive, and the Hale Creek Confluence.

Right-of-Way:
Mostly a 7.6m (25ft) easement
Some sections vary 7.6m to 16.75m (25ft to 55ft) easement and fee

Reach Slope: 0.0066 (slope measurement from sta 8+013.5 to sta 9+100)

1% Flow: 28 cms (1000 cfs)
10% Flow: 11 cms (400 cfs)

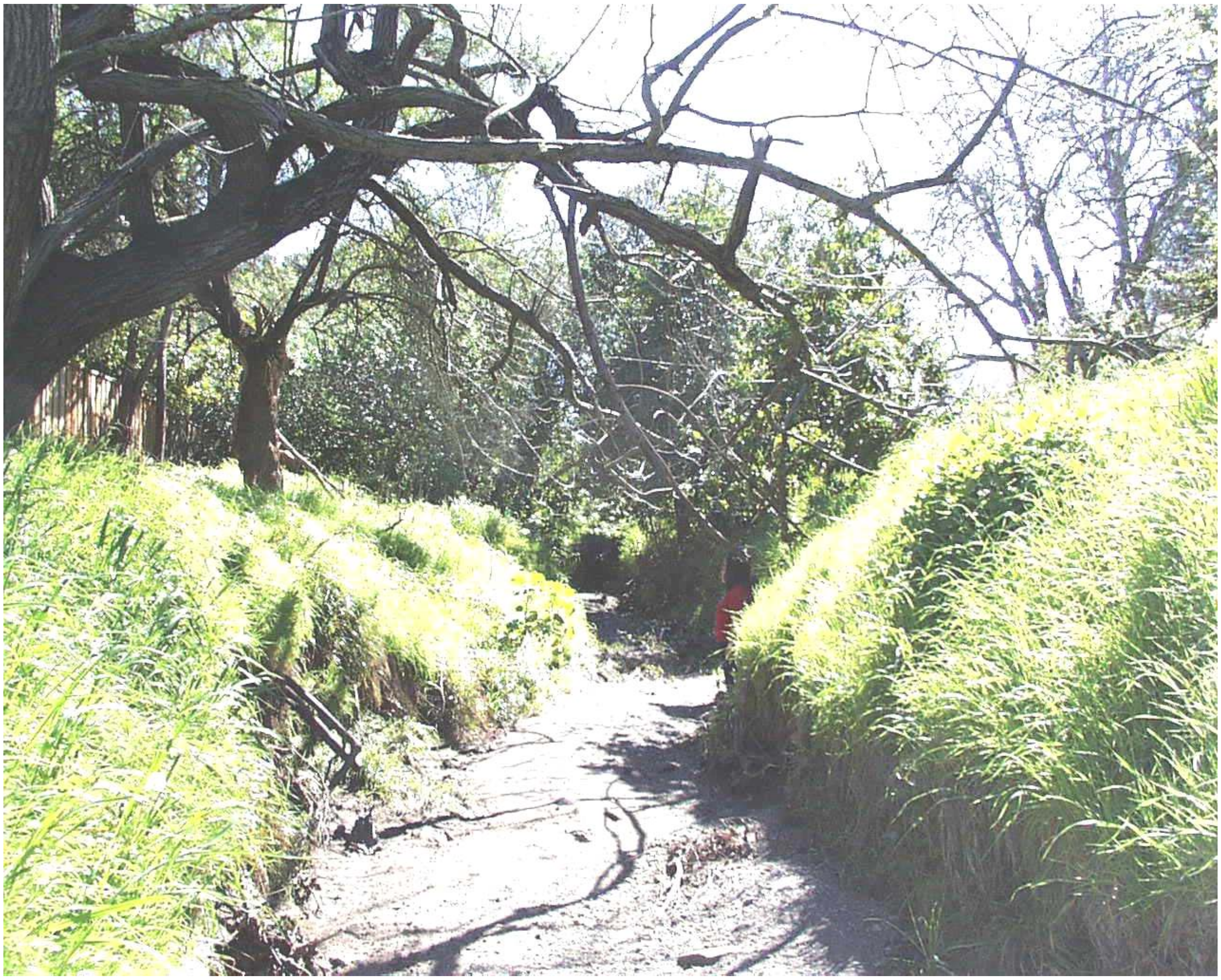
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
Hale Creek Confluence to Marilyn Drive	10	350
Marilyn Drive Bridge	8	300
Marilyn Drive to Barbara Ave	6	200
Barbara Ave Bridge	7	250
Barbara Ave to Miramonte/Cuesta Avenues	8	300

Reach Roughness Coefficient: Reach channel composite roughness varies between 0.028 and 0.076

Typical Channel Photos: See the following pages for channel descriptions and typical channel photos.

Permanente Creek

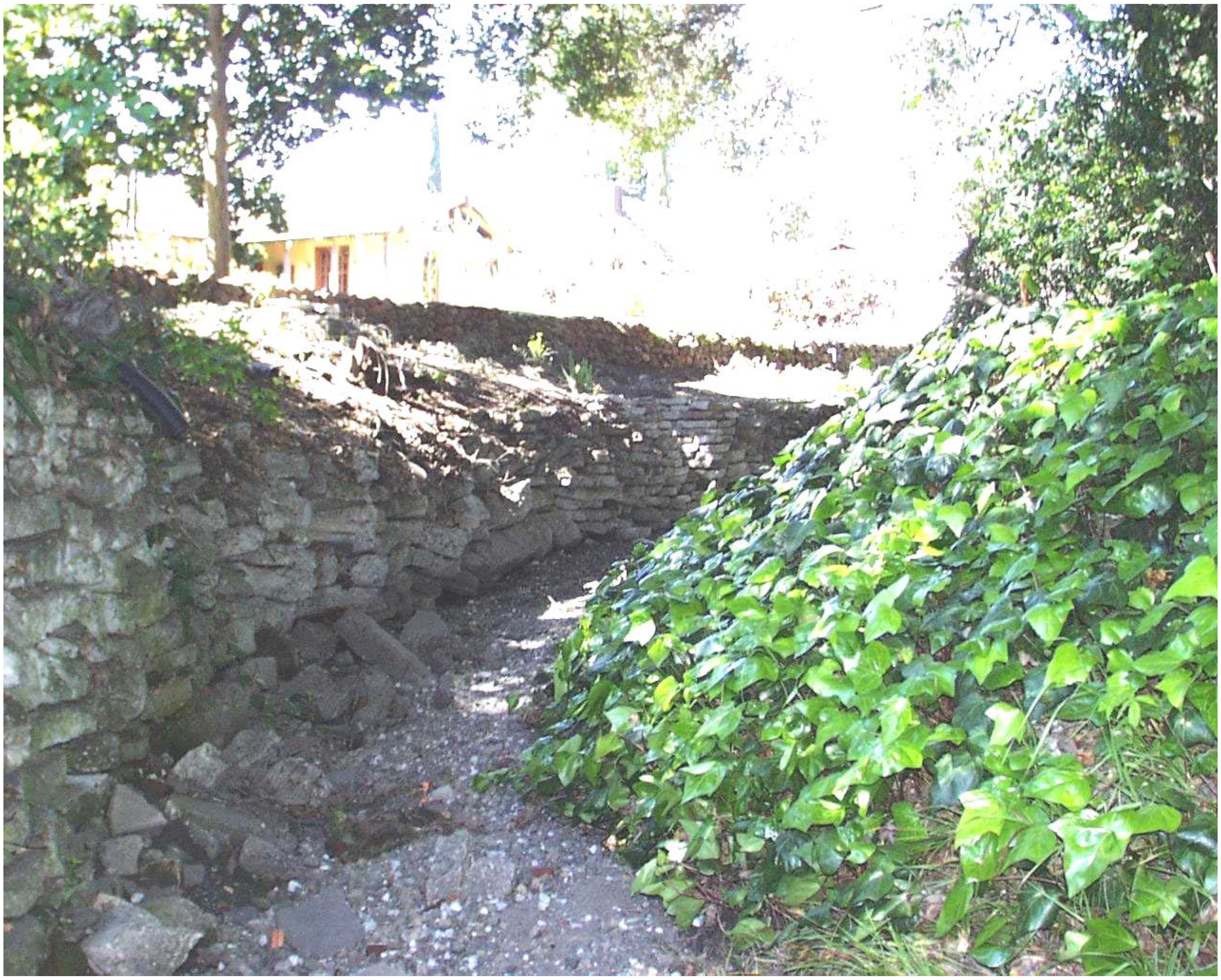


3/18/02 – Looking upstream - just upstream of Hale Creek Confluence

Channel Description:

The channel is natural and has mild to sharp curves. The natural shape varies and is small in area. The east and west banks consist mainly of mature trees with grass. The channel invert is sandy and gravelly.

Permanente Creek

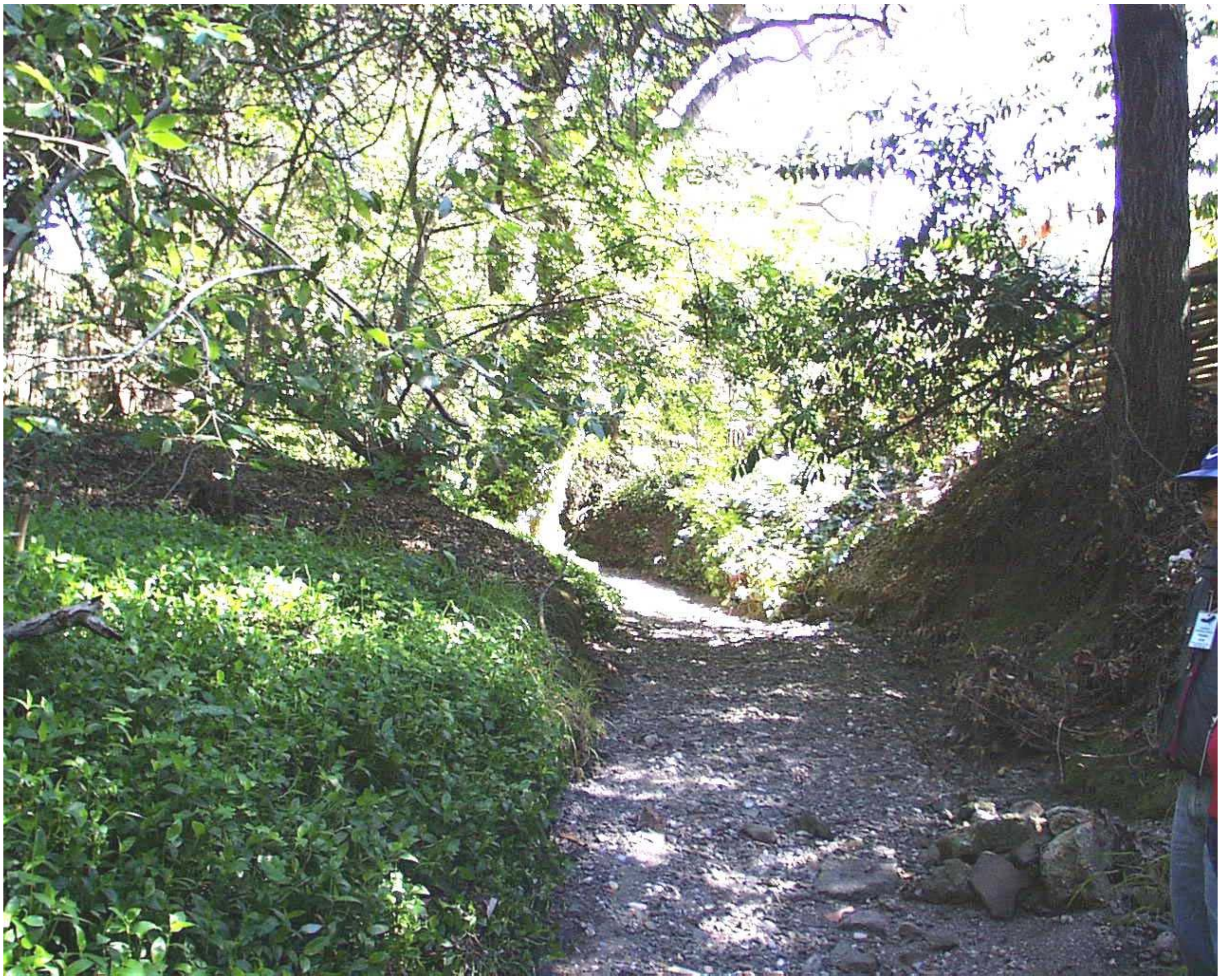


3/18/02 – Looking downstream – 90 m Reach Between Hale Creek Confluence and Marilyn Drive

Channel Description:

The channel is sinuous and has a natural shape. The banks vary, with the West bank consisting of a stacked concrete wall and the East bank vegetation consisting of bushy ivy with small to large trees. The channel invert is very rocky with some large rocks throughout the section (rocks up to 0.3m in diameter).

Permanente Creek

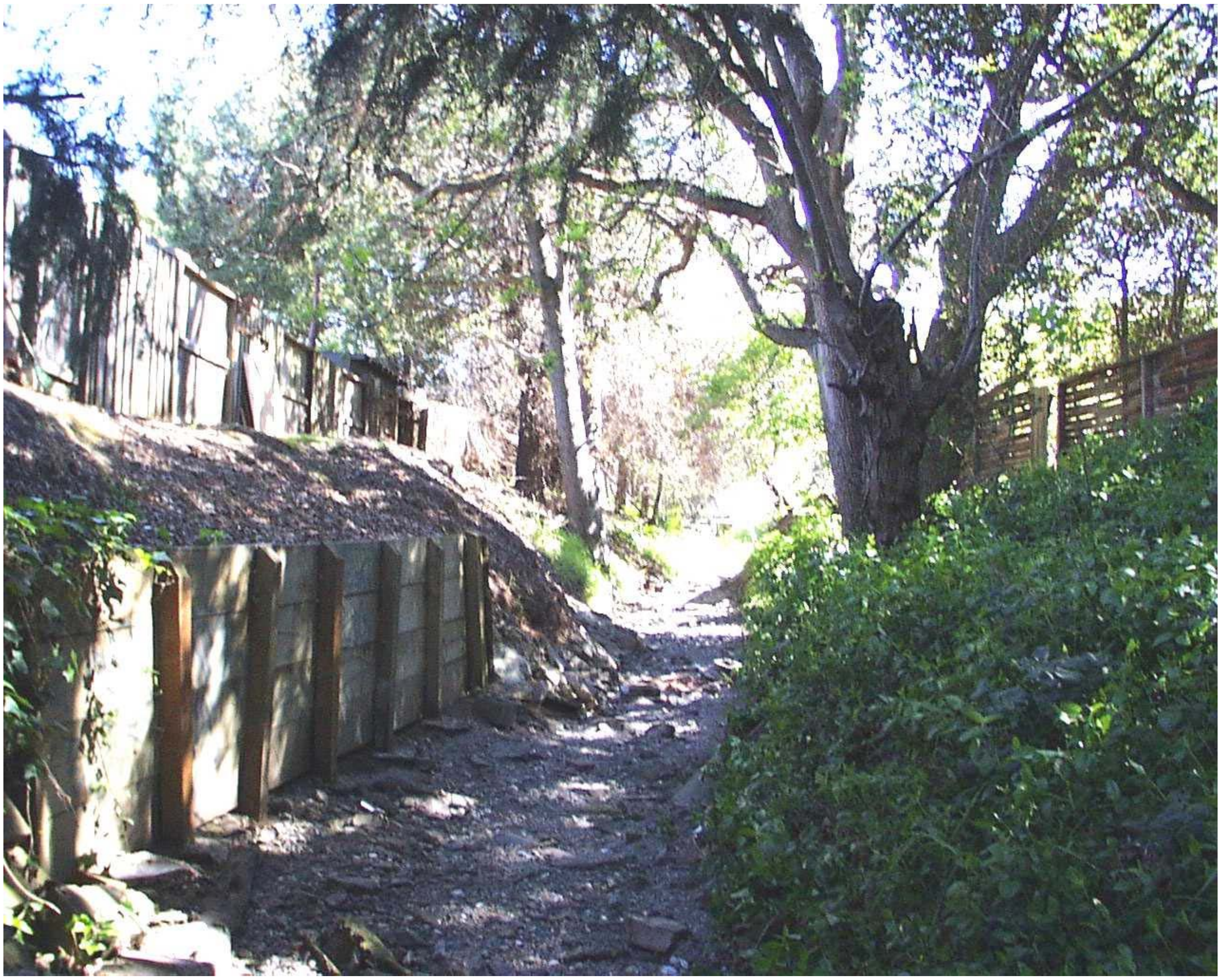


3/18/02 – Looking upstream - 60m section between Hale Creek Confluence and Marilyn Drive

Channel Description:

The channel is natural with some minor meandering. The East bank has a very shallow, wide slope, while the West bank has a steep, short slope. The vegetation consists of bushy ivy with small to large trees; some areas are bare soil. The channel invert consists mostly of gravel and dirt with particle size ranging up to 2cm.

Permanente Creek

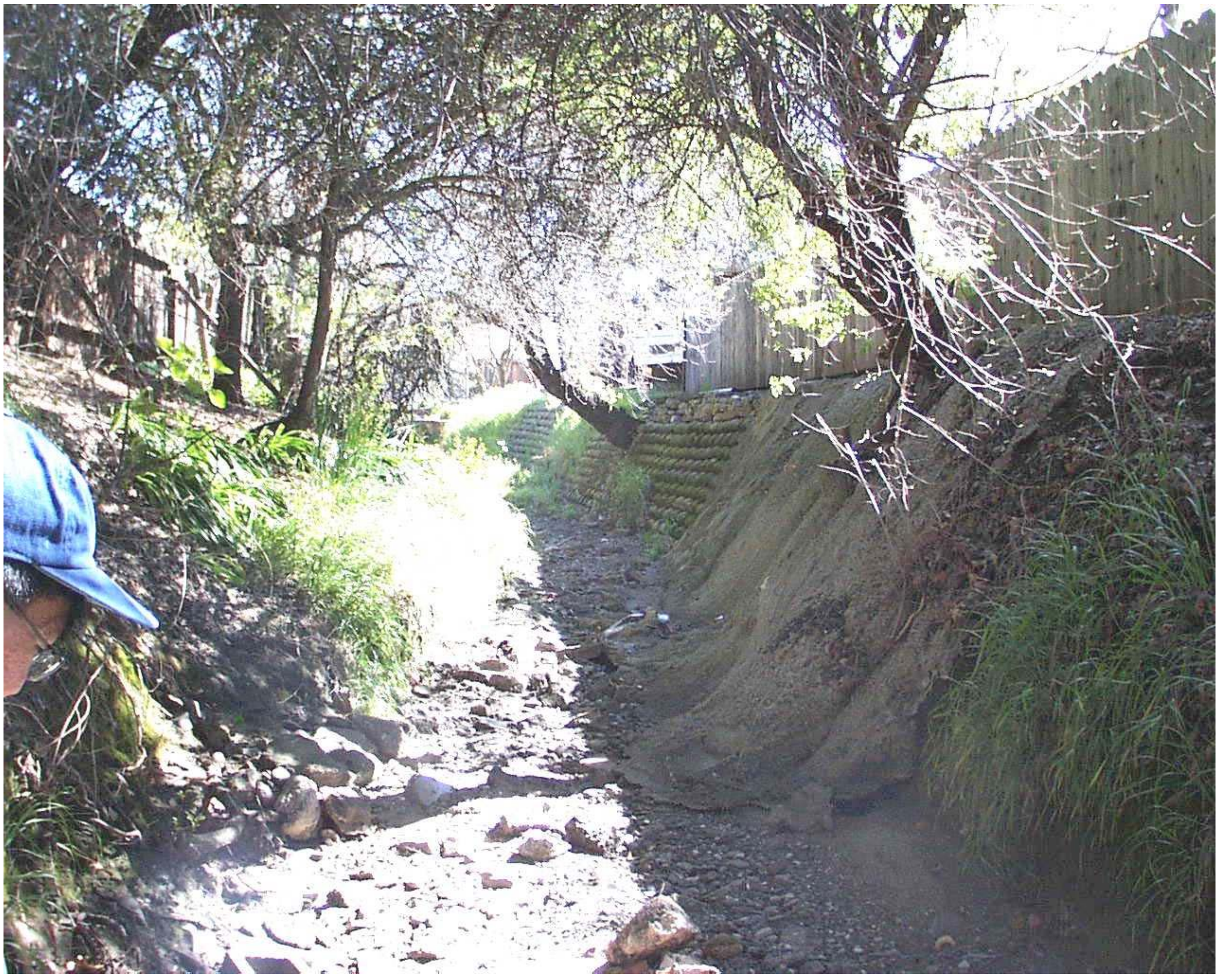


3/18/02 – Looking upstream - 35m section between Hale Creek Confluence and Marilyn Drive

Channel Description:

The channel is natural and straight and varies in shape. The vegetation on the banks is mainly ivy and mature trees; on the East bank there is a small section with a vertical wooden wall. The channel materials consist of gravel and dirt. Particle sizes range up to 2cm.

Permanente Creek

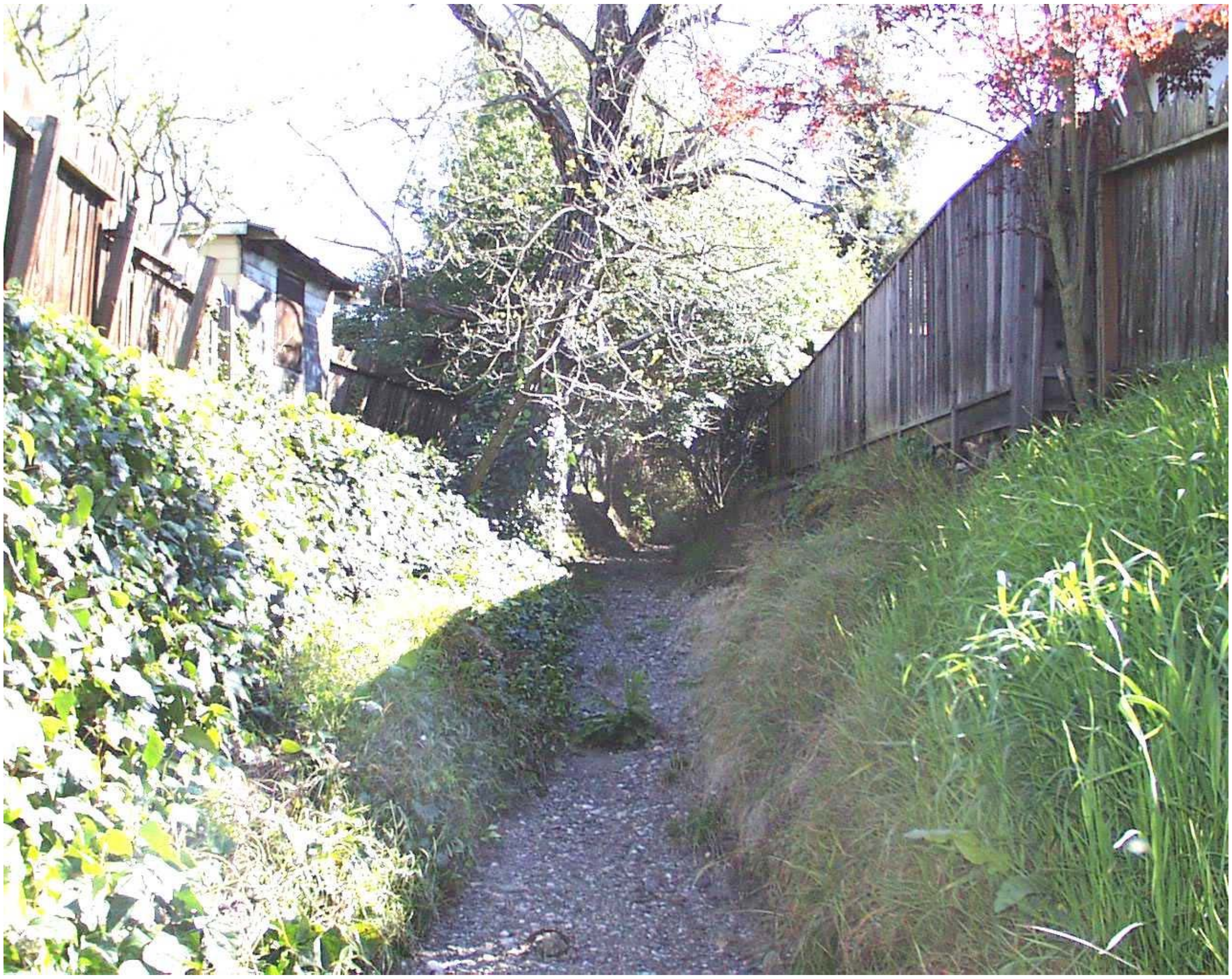


3/18/02 – Looking upstream - D/S of Marilyn Drive

Channel Description:

The trapezoidal-shaped channel is primarily straight and consists of sections of natural banks, SCSP, and gunite. The East bank has scattered mature trees and small patches of grass; the West bank is mainly SCSP with some grass, a small section of gunite, and an occasional tree in the SCSP. The invert material consists mainly of cobbles with some small boulders (rock size mainly between 2cm to 15cm).

Permanente Creek

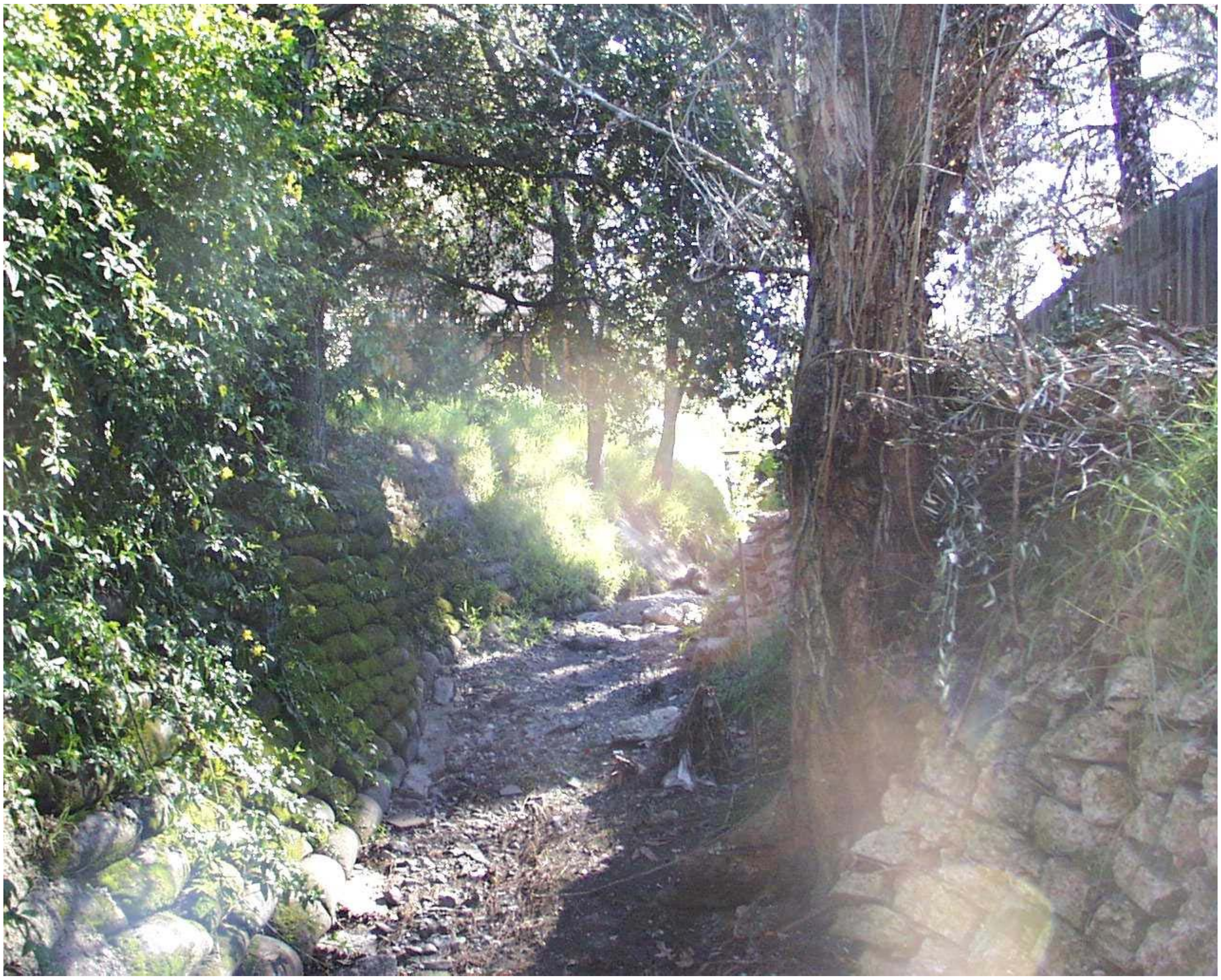


3/18/02 – Looking upstream - between Marilyn Drive and Barbara Ave.

Channel Description:

The trapezoidal, natural channel has a straight planform. Channel vegetation consists of grass and ivy on banks with occasional mature trees. Channel invert material consists of mainly gravel with dirt. Particle sizes range up to 2cm.

Permanente Creek

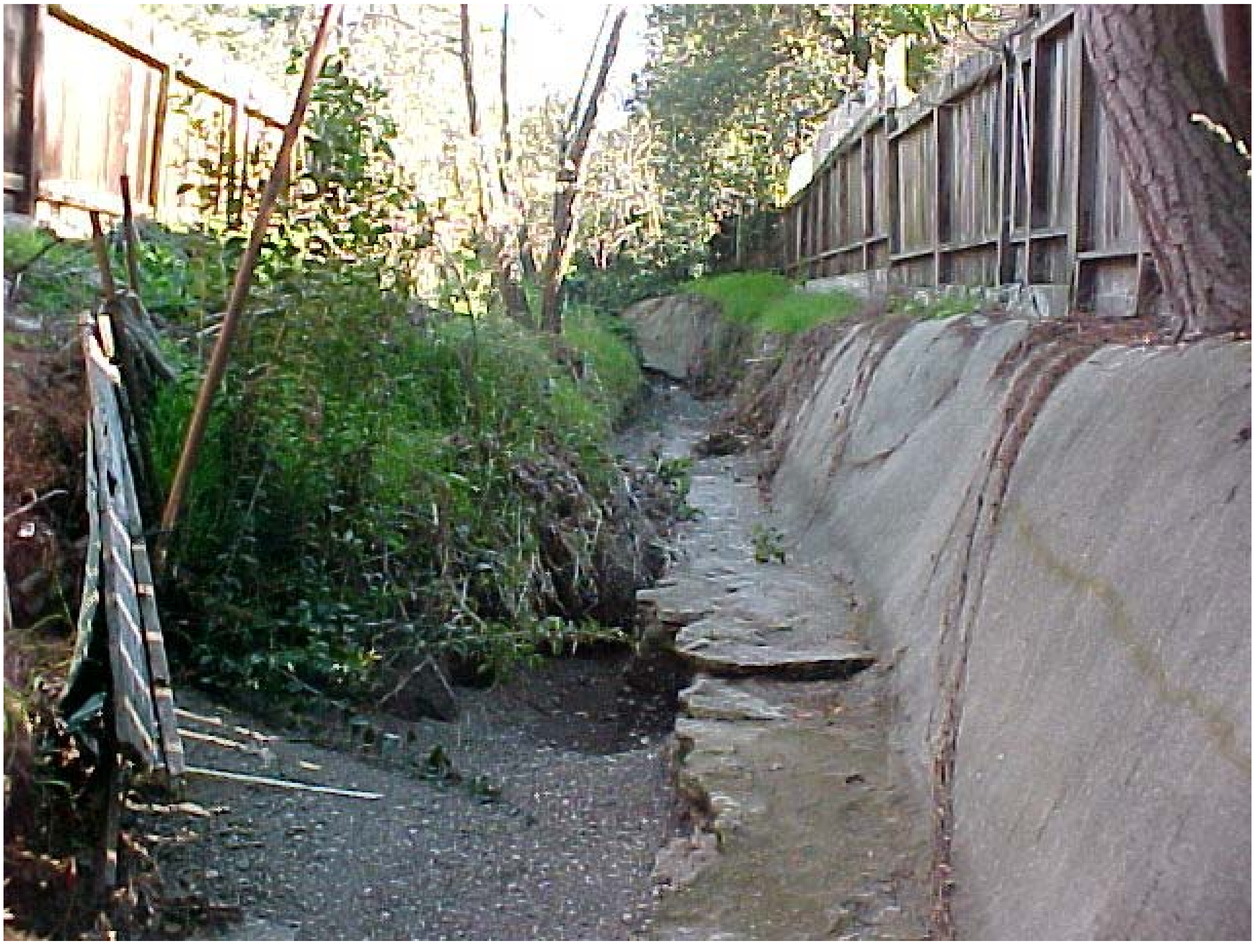


3/18/02 – Looking upstream - between Marilyn Drive and Barbara Ave.

Channel Description:

The channel is natural with a slight meander and is trapezoidal in shape. The channel banks are steep and consist of SCSP with grass cover and several trees growing out of the sacked banks. The channel invert is rocky with gravel and cobbles. Rock size mainly ranges from 1” to 3” diameter.

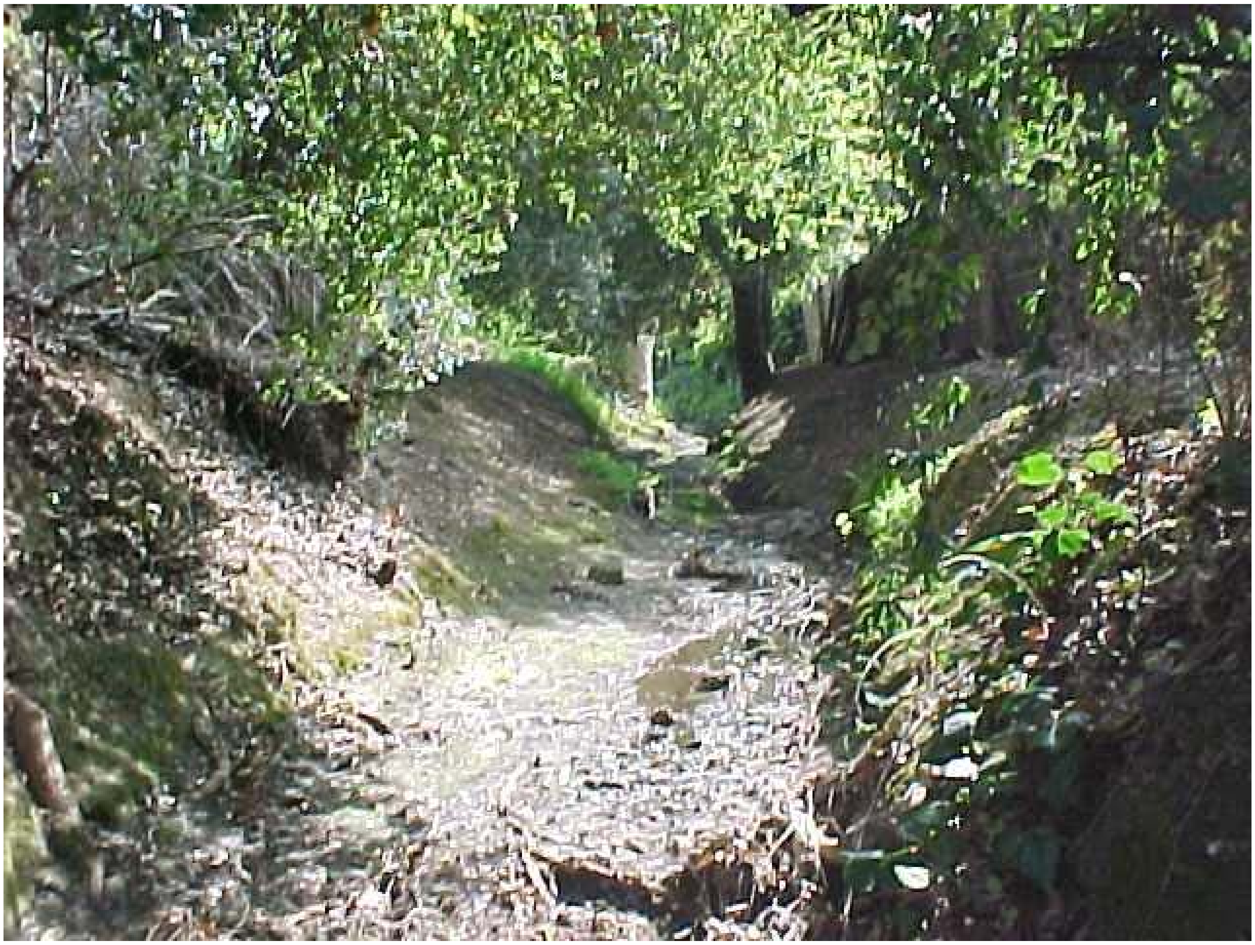
Permanente Creek



3/18/02 – Looking upstream - between Marilyn Drive and Barbara Ave.
Channel Description:

The channel is straight and varies in shape. The East bank is natural with undergrowth as vegetation and the West bank is gunite. The invert appears sandy with the natural vegetation encroaching on the East side and the gunite on the West side.

Permanente Creek



3/20/02 – Looking upstream - Barbara Avenue to Miramonte/Cuesta Avenues
Channel Description:

The channel is natural with a slight meandering alignment and is trapezoidal in shape. Bank vegetation varies from bare earth to mature trees without any undergrowth. The channel bottom is gravelly.

Reach P7: Cuesta/Miramonte Ave to Diversion (Sta 9+100 to Sta 10+533)

Reach Description:
This reach is mainly a natural, trapezoidal-shaped channel with steep banks. The vegetation consists mainly of mature trees with little or no undergrowth. There are no maintenance ramps to gain access to the creek along this reach. There is a gate at the Covington Bridge for access to the old stream gage at that location. There is one main vertical drop just downstream of Abandoned Bridge #31.

Right-of-Way: varies
9+227 to 9+729: 7.6m± (25ft±) easement
9+729 to 10+523: 7.5m to 30.5m (25ft to 100ft) fee and easement

Reach Slope: 0.0096 (slope measurement from 9+100 to 10+523)

1% Flow: 28 cms (1000 cfs)
10% Flow: 11 cms (400 cfs)

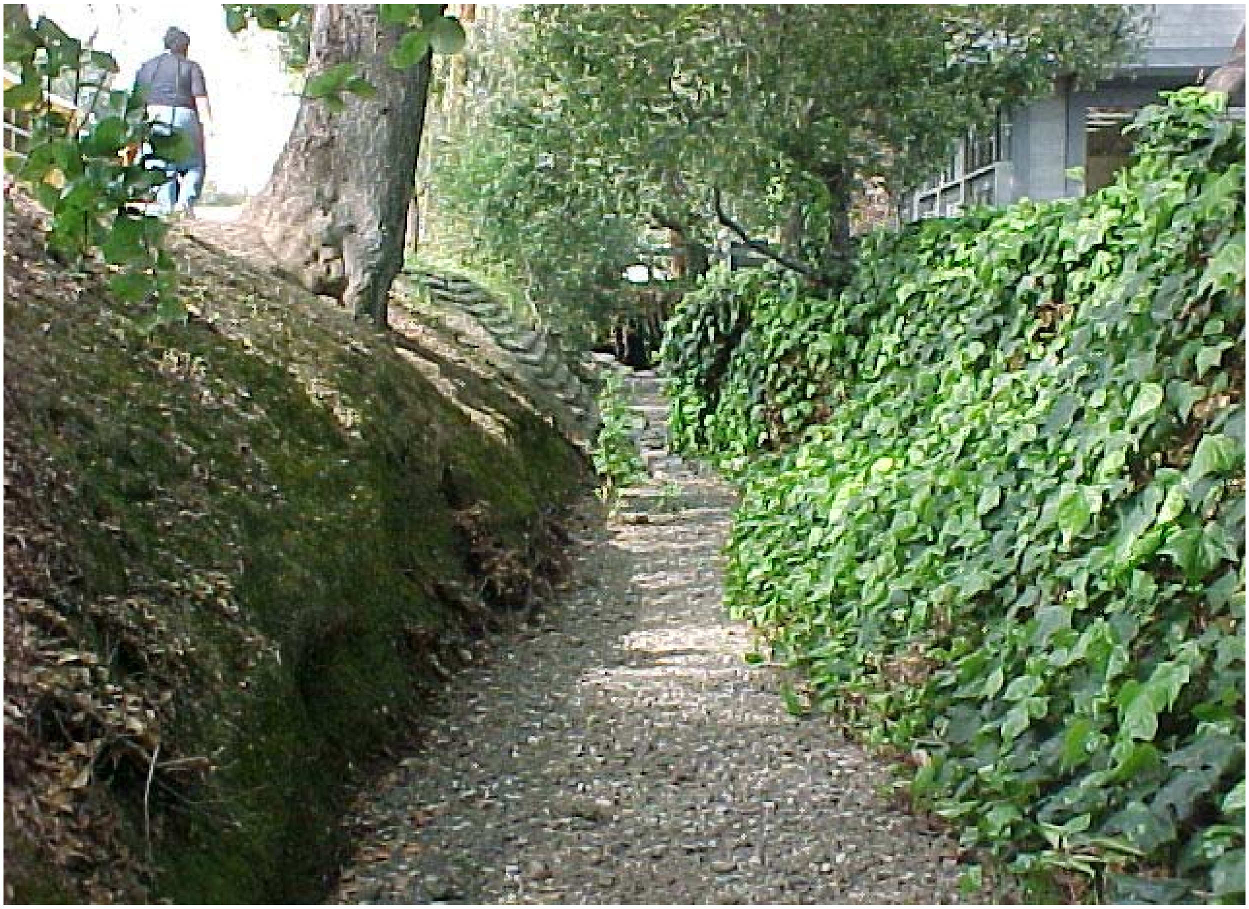
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
Miramonte/Cuesta Culvert	12	400
Culvert to Villa Siena	16	550
Villa Siena Bridge	17	600
Villa Siena to St. Francis Walkway	19	650
St. Francis Walkway Bridge	25	900
St. Francis Walkway to St. Francis Exit	25	900
St. Francis Exit Bridge	25	900
St. Francis Exit to St. Francis Entrance	27	950
St. Francis Entrance Bridge	20	700
St. Francis Entrance to Abandoned Bridge #30	25	900
Abandoned Bridge #30	40	1400
Abandoned Bridge #30 to Abandoned Bridge #31	35	1200
Abandoned Bridge #31	23	800
Abandoned Bridge #31 to Covington Rd	16	550
Covington Rd Bridge	14	500
Covington Rd to 54" Diversion Pipe	9	300

Reach Roughness Coefficient: Composite Channel Roughness Varies from 0.03 to 0.061

Typical Channel Photos: See the following pages for channel descriptions and typical channel photos.

Permanente Creek

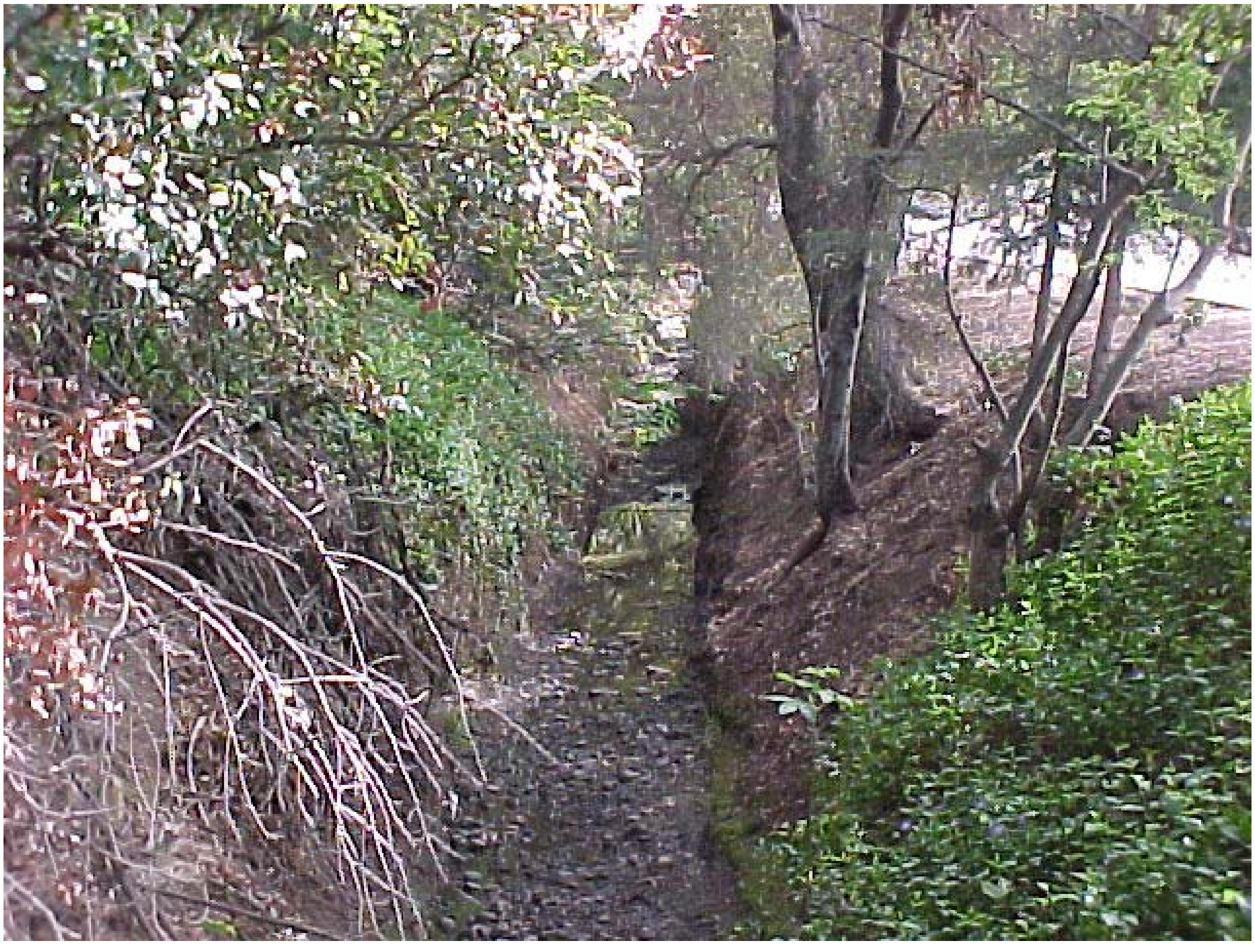


3/20/02 – Looking Downstream - Miramonte/Cuesta to Villa Siena bridge

Channel Description:

The channel is natural and straight in form. The natural shape varies, but is typically trapezoidal. On the West bank, channel vegetation varies from bare earth, to mature trees with limited undergrowth, to SCSP. The East bank consists mainly of mature trees with limited to no undergrowth (some sections are covered with ivy, but most are bare). The channel material is gravel and dirt. Sediment size ranges up to 2cm in diameter.

Permanente Creek

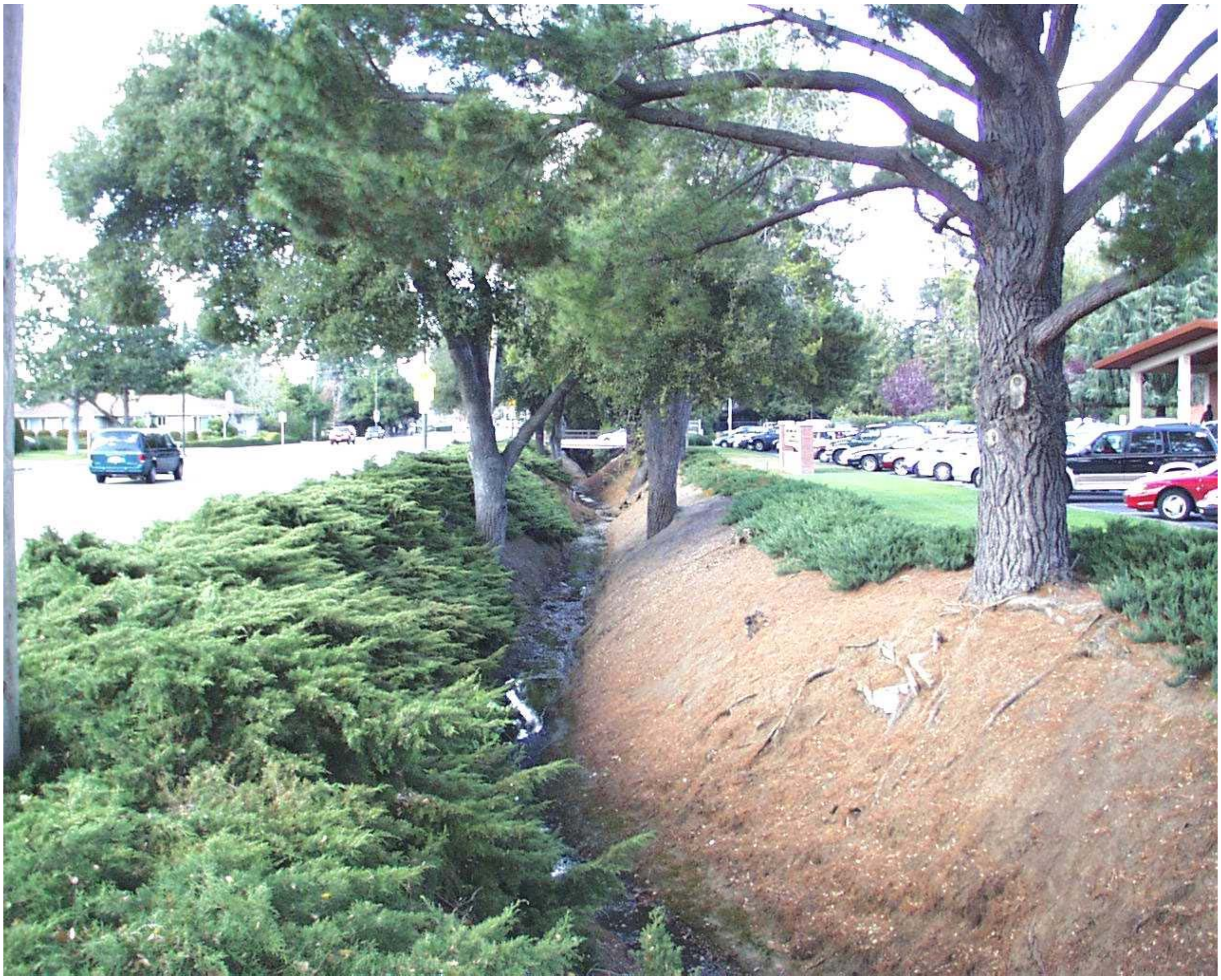


3/20/02 – Looking upstream - Villa Siena to St. Francis Walkway

Channel Description:

The channel is natural and straight in alignment. The shape varies, but is mainly trapezoidal. The vegetation on the East bank is mainly mature trees with some bushes. The West bank varies from bare earth to mature trees with very little undergrowth. The channel material is gravel and dirt.

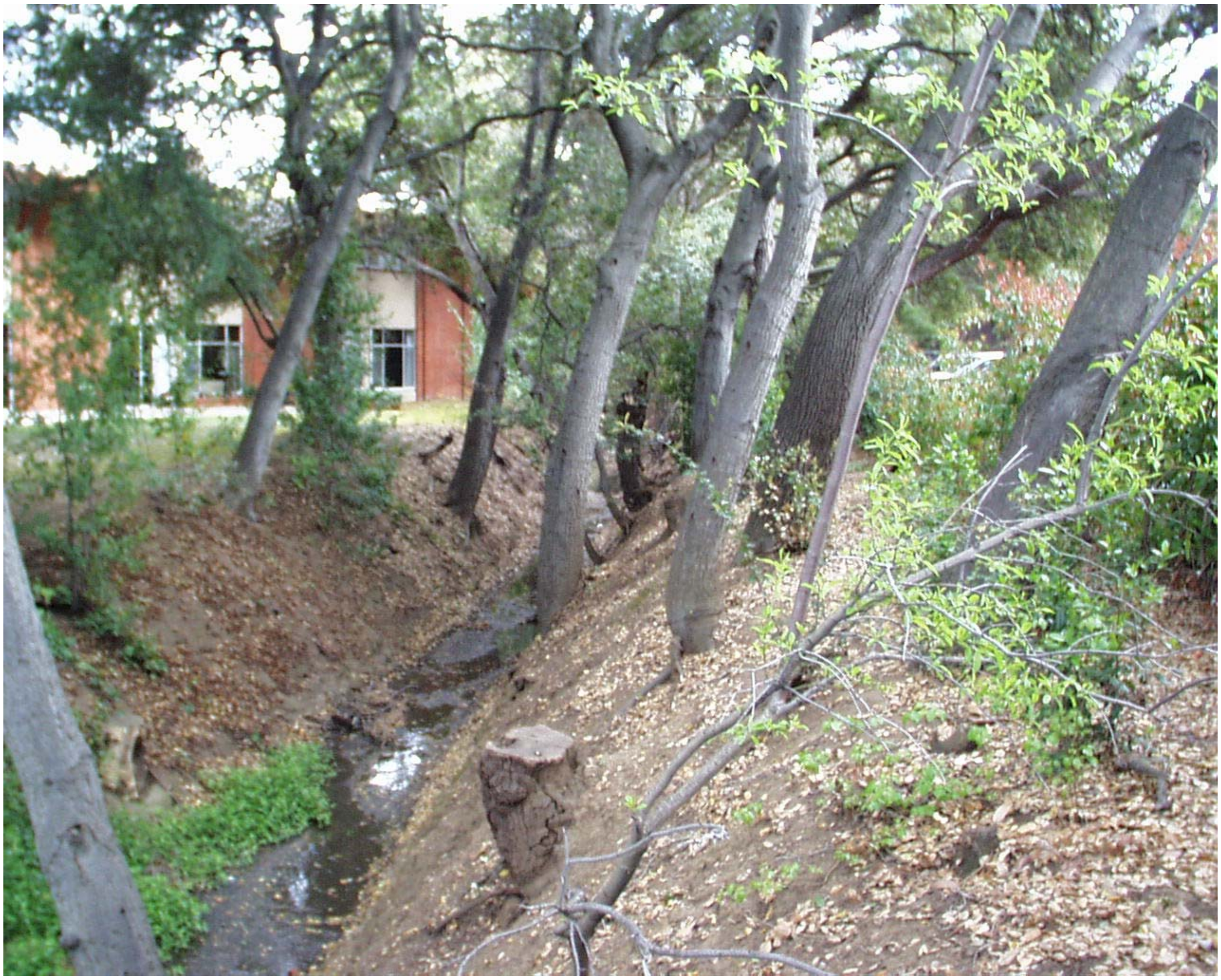
Permanente Creek



3/15/02 – Looking downstream – St. Francis Exit to St. Francis Entrance
Channel Description:

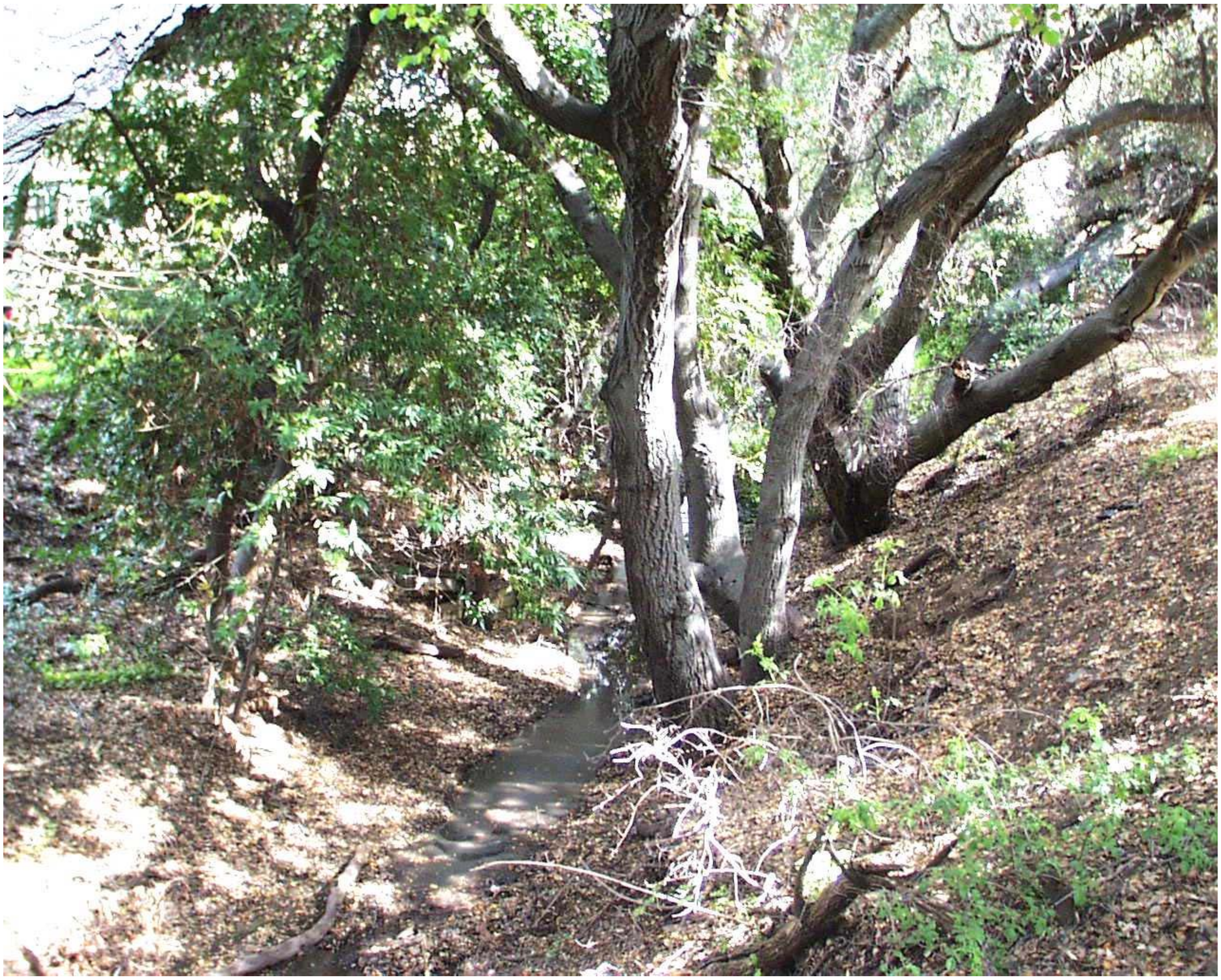
The channel is natural and trapezoidal in shape with minimal meandering. The channel has steep banks and a narrow invert. The vegetation on the West bank consist a dense low ground cover with some mature trees while the East bank is bare earth with some mature trees. The channel material consists of silt and mud.

Permanente Creek



3/15/02 – Looking upstream – St. Francis Entrance to Abandoned Bridge #30
Channel Description:
The natural channel is straight and trapezoidal in shape. The vegetation along the banks consists of mature trees with little to no groundcover. The channel material is composed of silt and mud.

Permanente Creek

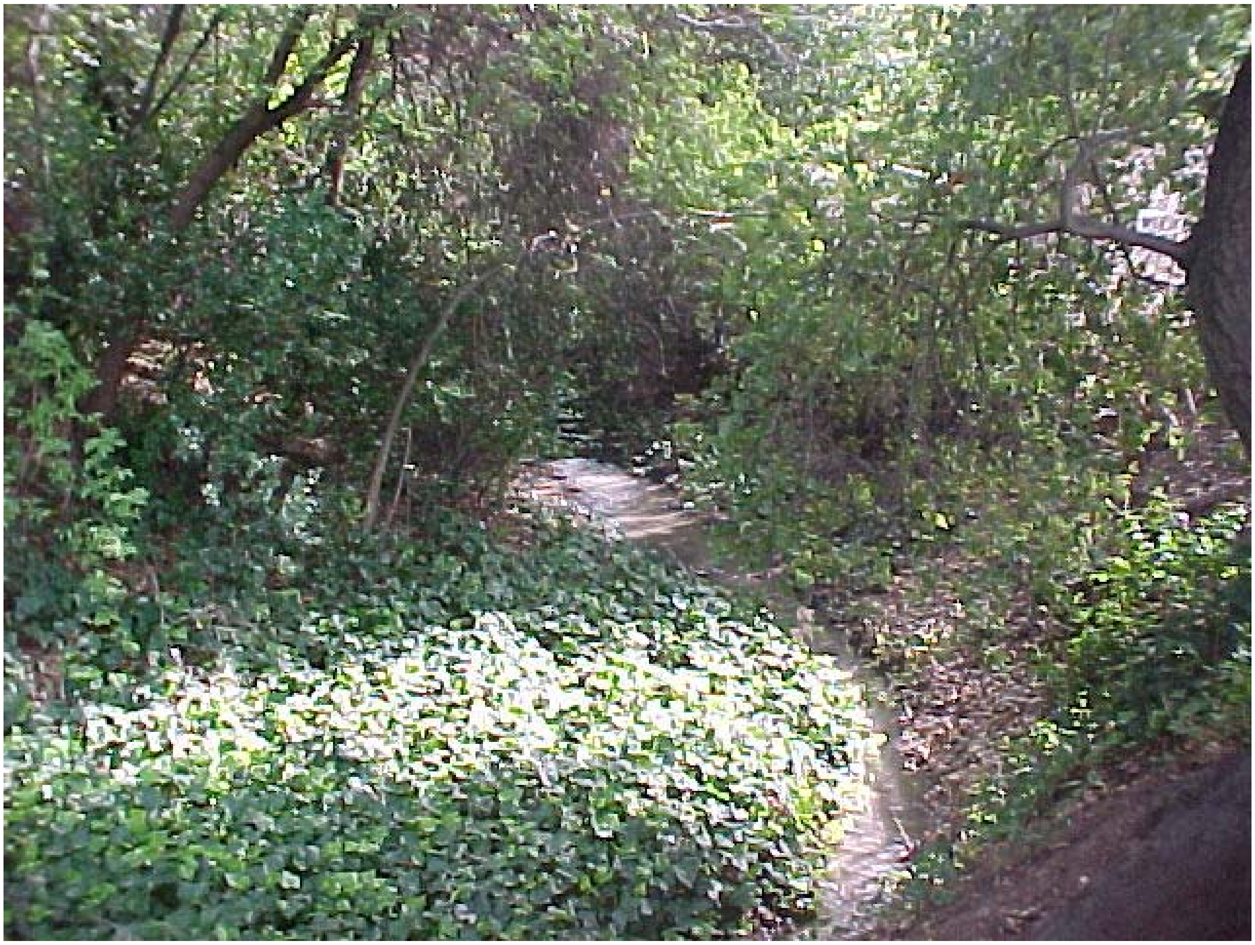


3/15/02 – Looking upstream - Abandoned Bridge #30 to Abandoned Bridge #31

Channel Description:

The natural channel is straight and trapezoidal in shape. The vegetation on the banks consists mainly of mature trees with little to no undergrowth. The channel material consists of silt and mud.

Permanente Creek

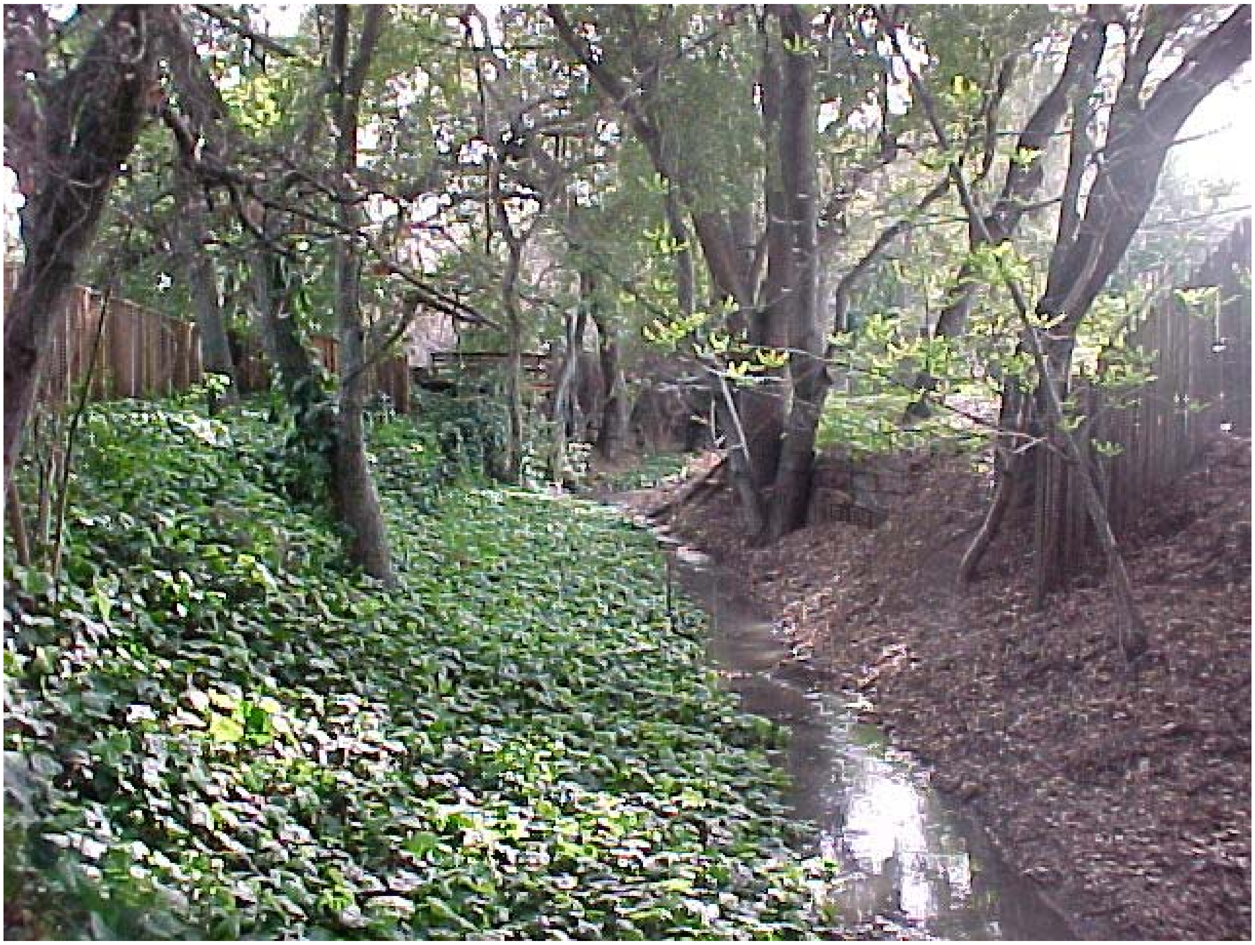


3/20/02 – Looking upstream - Abandoned Bridge #31 to Covington Road

Channel Description:

The channel is natural and changes from trapezoidal to flat and wide. The channel also transitions from straight to large meanders. There is heavy vegetation presence with mature trees and undergrowth of grass and ivy. The channel material is silty and muddy.

Permanente Creek



3/20/02 – Looking upstream - Covington Road to 54" Corrugated Metal Pipe (CMP)

Channel Description:

The natural channel transitions from straight in some parts to meandering in others. It is wide with long, sloping banks. The vegetation on the East bank is mature trees with limited undergrowth (ivy), and on the West bank it is mainly mature trees with little to no undergrowth. The channel material is sandy and silty with some gravel.

Reach P8: Diversion Pipe to Foothill Expressway (Sta 10+533 to Sta 11+979)

Channel Description:
This reach has three major sections: 1) the 54” CMP which is about 65 meters long; 2) a concrete trapezoidal section about 340 meters long; 3) and a natural channel from Portland Ave. to Foothill Expwy. There are two maintenance ramps along the trapezoidal channel just upstream of the 54” CMP. There are two main drop structures in this reach, one just downstream of the Gage Bridge, the other about 50 meters downstream of the Portland Ave. Bridge.

Right-of-Way: varies
10+585.94 – 10+583: 3m±± (10ft) easement (for 54” pipe)
10+583 – 10+933: 15.2m± (50ft±) fee mostly, some easement
10+933 – 11+978.73: 12 to 30m (40 to 100ft) fee +easement

Reach Slope: 0.01 (slope measurement from 10+523 to 11+978)

1% Flow: 76 cms (2700 cfs)

10% Flow: 42 cms (1500 cfs)

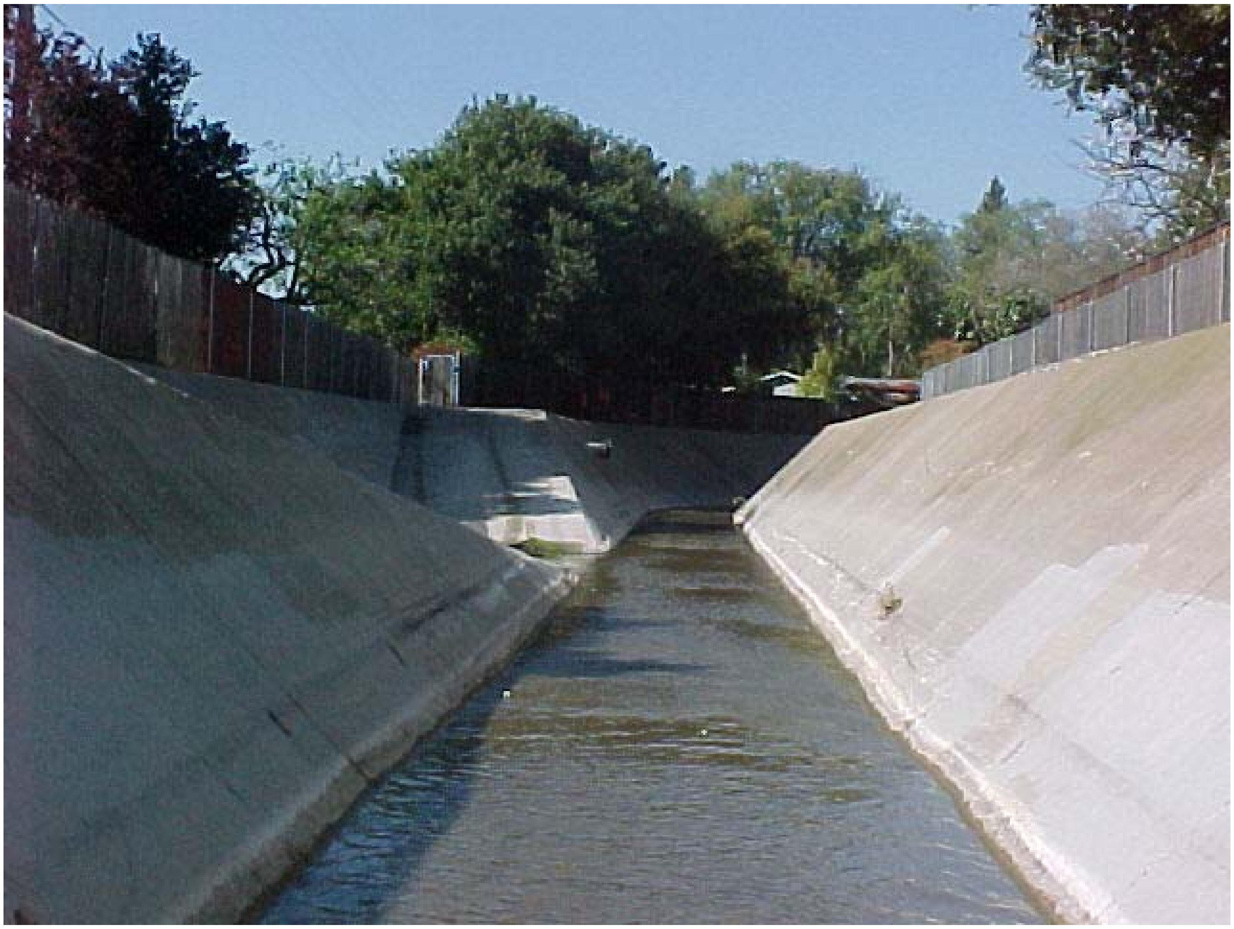
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
54” CMP (note: pipe regularly clogs with sediment)	6	200
Diversion to Gage Bridge	48	1700
Gage Bridge	159	5600
Gage Bridge to Portland Ave.	82	2900
Portland Ave. Bridge	59	2100
Portland Ave. to Aura Way	27	950
Aura Way Bridge	90	3200
Aura Way to Fremont Ave.	134	4700
Fremont Ave. Bridge	182	6400
Fremont Ave. to Foothill Expwy.	172	6100

Reach Roughness Coefficient: Composite channel roughness varies between 0.015 to 0.095

Typical Channel Photos: See the following pages for channel descriptions and typical channel photos.

Permanente Creek

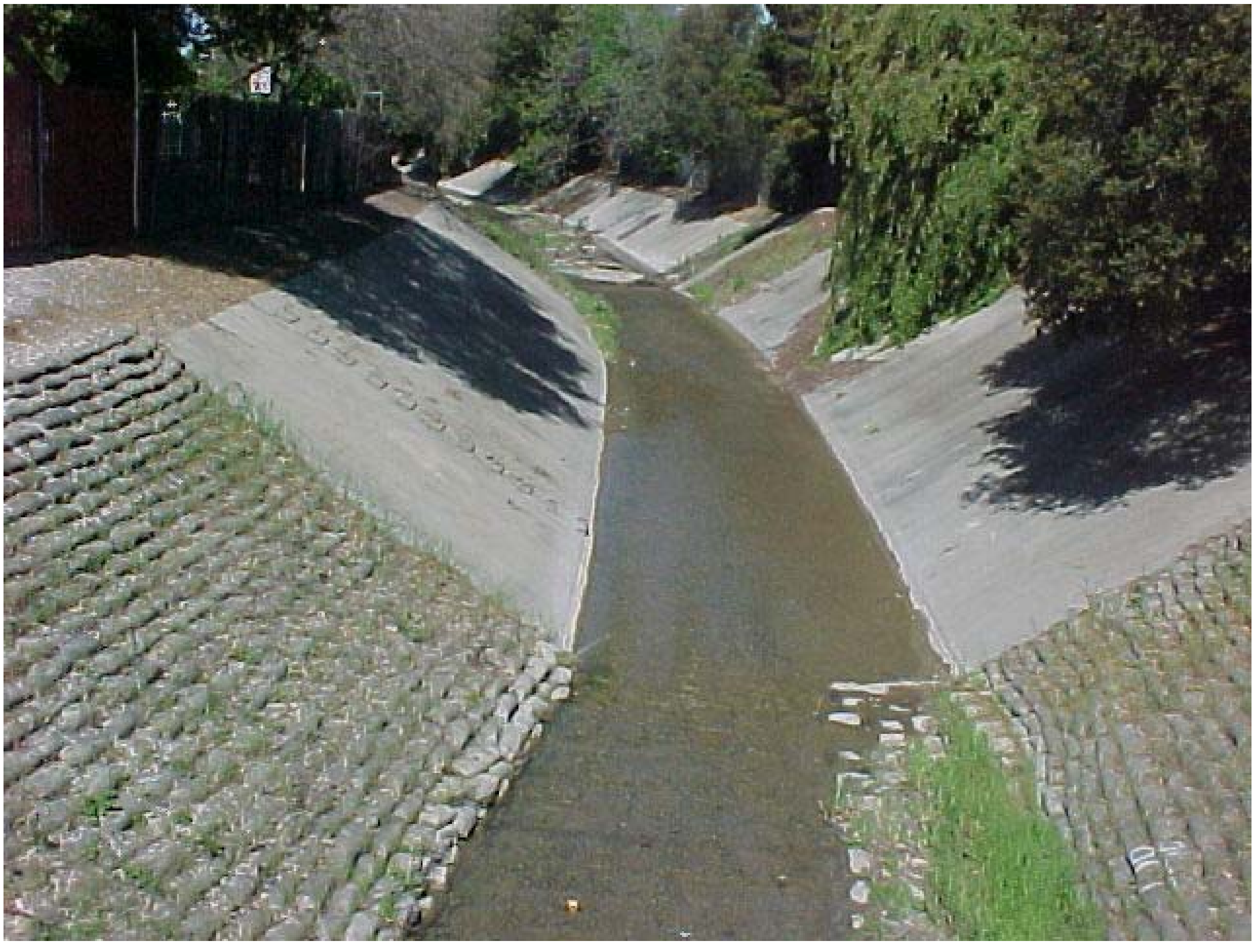


3/28/02 – Looking downstream - Diversion structure to Gage Bridge

Channel Description:

The channel is a concrete trapezoid. The alignment is straight with the exception of a 90 degree bend which turns the channel to the diversion. There are two maintenance ramps on the West bank just upstream of the bend. The banks and invert are concrete and are in moderate condition with: minor abrasion, moderate popouts, moderate to significant shear cracks, and moderate to significant exposed rebar. There is no vegetation and sedimentation in the channel. There is a .9 m drop just D/S of Gage Bridge.

Permanente Creek

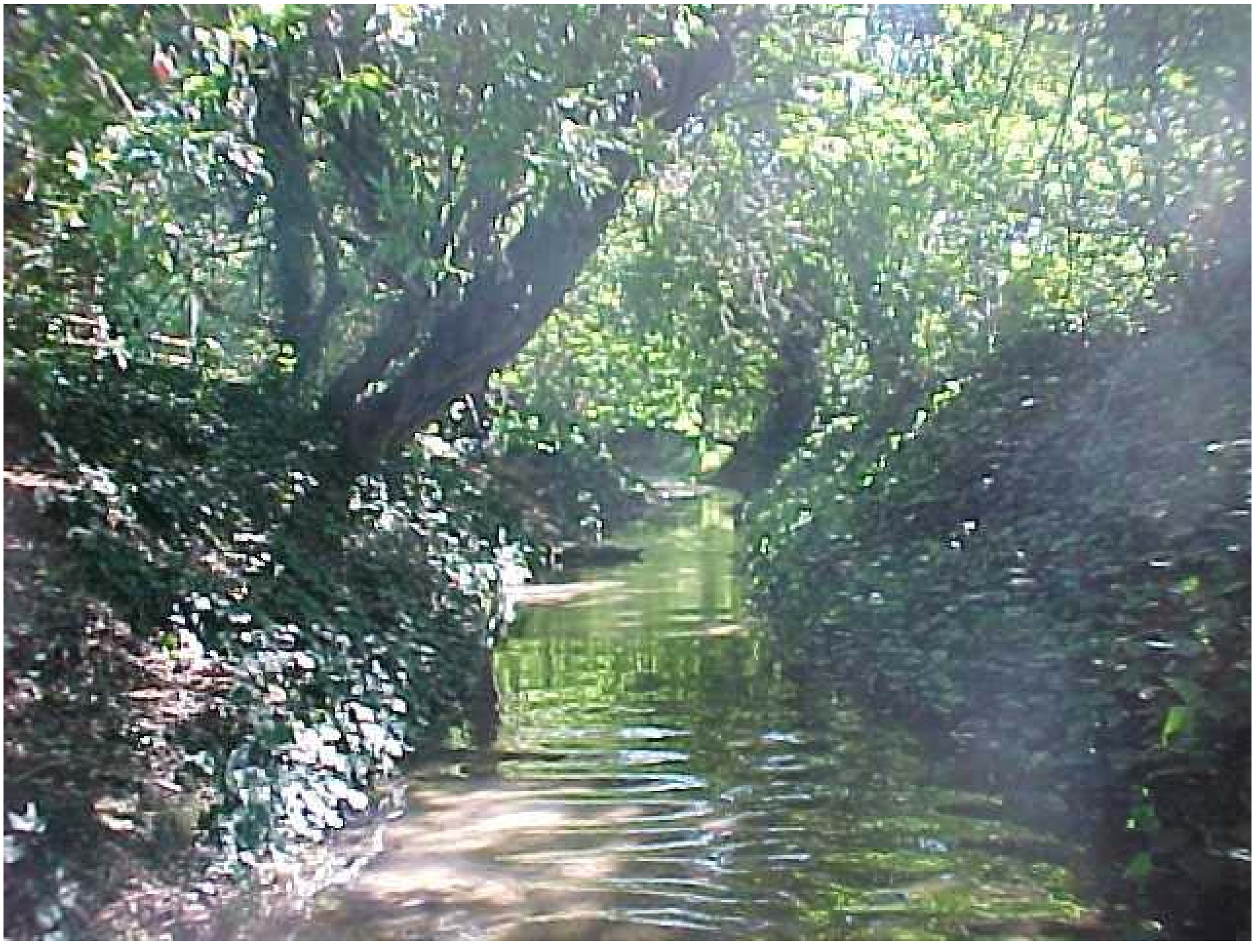


3/27/02 – Looking downstream - Gage Bridge to Portland Avenue

Channel Description:

The channel is a concrete trapezoid with a straight alignment. The banks and invert are concrete and are in moderate condition with minor abrasion, moderate popouts, moderate to severe shear cracks, and moderate to severe exposed rebar. There is some sedimentation in a few sections of the reach with minor growth of grass. There are also some areas of SCSP (e.g. around the drop) with limited grass growing between the sacks. Just downstream of Portland Ave., in about a 25m long section, the channel is all SCSP, including the invert. There is a 1.1 m drop structure at the end of this SCSP section.

Permanente Creek

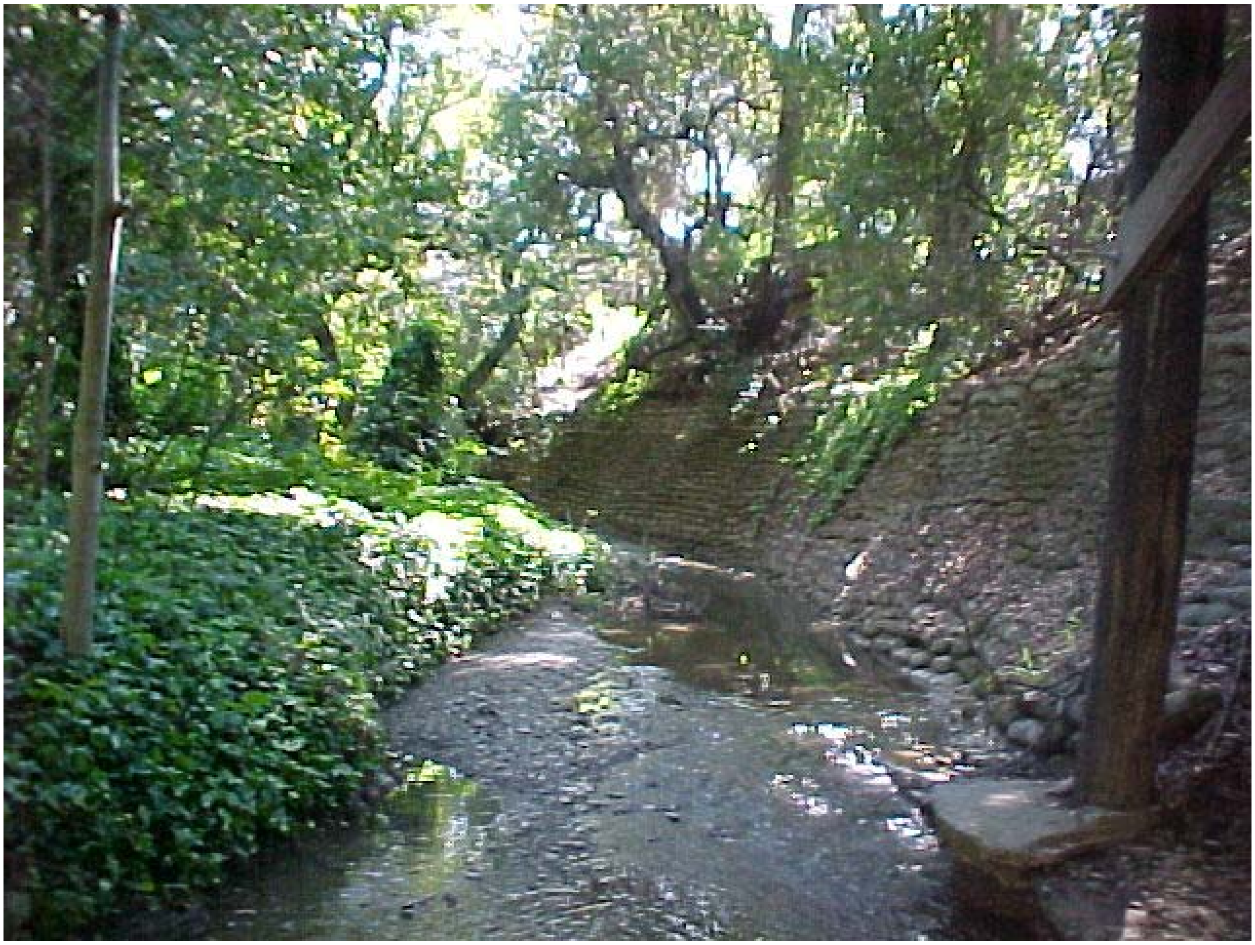


3/27/02 – Looking upstream - Portland Avenue to Aura Way

Channel Description:

The channel is natural and trapezoidal in shape and varies from straight to mildly sinuous sections. The vegetation on the banks consists mainly of mature trees with limited to substantial undergrowth. The mature trees create a canopy over the creek; vines and brush make up most of the undergrowth. The channel material consists of silt with gravel-sized sediment. There are two concrete drop structures within this reach.

Permanente Creek

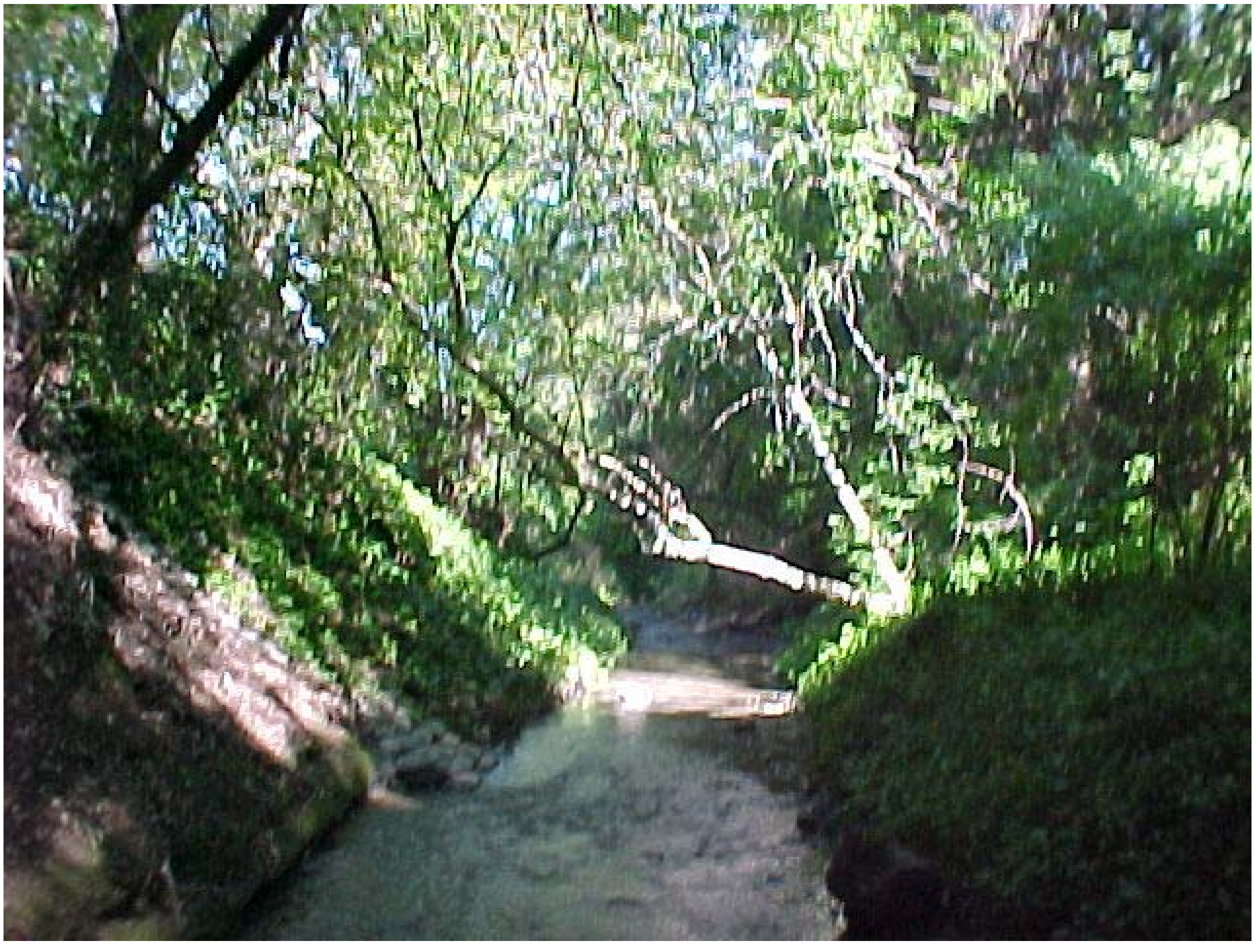


3/27/02 – Looking upstream – 115 m section upstream of Aura Way

Channel Description:

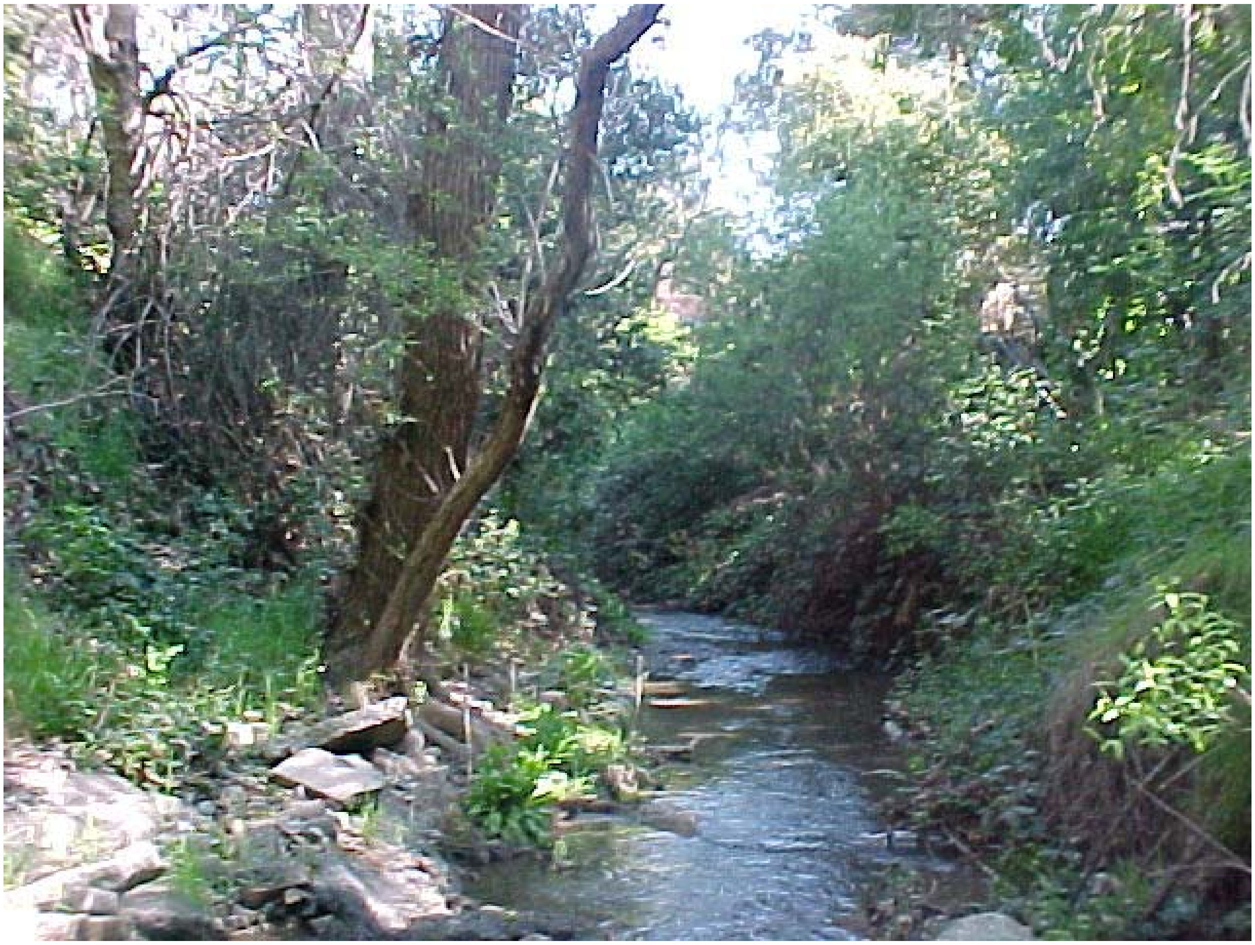
The channel is natural, combined with sacked concrete slope protection; the alignment varies from straight to large meanders. The west bank consists of SCSP (at a steep slope) to about 3.5m above the channel invert. The east bank consists mostly of mature trees with limited to substantial undergrowth. The channel material is mainly silt and gravel. Gravel range in size up to 5cm in diameter.

Permanente Creek



3/28/02 – Looking downstream - Aura Way to Fremont Avenue
Channel Description:
The channel is natural and varies from straight to sinuous. The vegetation on the banks consists of mature trees with bushes and grass as undergrowth. The channel material is mainly silt and gravel.

Permanente Creek



3/28/02 – Looking downstream – just downstream of Foothill Expressway

Channel Description:

Channel is natural and trapezoidal and meanders moderately. The banks are highly vegetated with mature trees, shrubs, and undergrowth. The channel material consists of gravel and sand with some broken concrete slabs.

HALE CREEK

Reach H1: Permanente Creek Confluence to Rosita Avenue (Sta 0+000 to Sta 1+745)

Channel Description:
In this reach, the channel varies from straight to mildly sinuous sections. All concrete sections are either U-frame or trapezoidal. All bridge crossings are freespans, with some private crossings composed of steel and wooden sections. Sedimentation on the invert is insignificant.

Right-of-Way: Varies
Mountain View Ave. to Arroyo Rd.; 6.1 to 18.3m (20-60ft); Fee, some easement
Arroyo Rd. to North Sunshine Dr.; 5.7 to 7.6m (18.75-25ft); Fee
North Sunshine Dr. to South Sunshine Dr.; 3.8 to 12.2m (12.5-40ft); Fee, some easement
South Sunshine Dr. to Springer Rd.; 7.6 to 12.2m (25-40ft); Fee
Springer Rd. to Cuesta Dr.; 7.6 to 11.5m (25-37.5ft); Fee, some easement
Cuesta Dr. to Arboleda Dr.; 7.6 to 15.2m (25-50ft); Fee
Arboleda Dr. to Rosita Ave.; 1.8 to 9m (6-30ft); Fee + easement

Average Reach Slope: 0.0077

1% Flow: 31 cms (1100 cfs)

10% Flow: 19 cms (660 cfs)

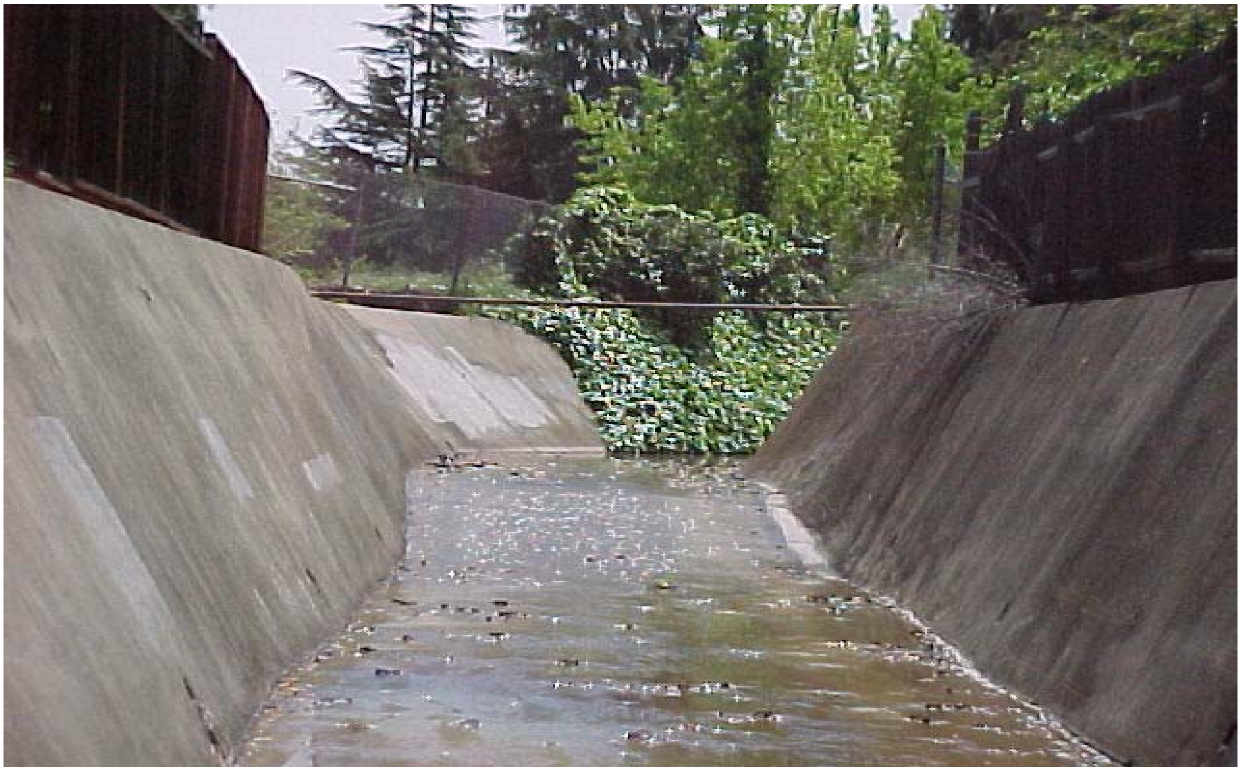
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
Permanente Creek to Mt. View Ave.	56	2000
Mt. View Ave. Bridge	22	800
Mt. View Ave. to Arroyo Rd.	22	800
Arroyo Rd. Bridge	52	1800
Arroyo Rd. to Marilyn Dr.	35	1200
Marilyn Dr. Bridge	35	1200
Marilyn Dr. to 7th Day Adventist	41	1400
7th Day Adventist Bridge	18	650
7th Day Adventist to North Sunshine Dr.	26	900
North Sunshine Dr. Bridge	18	650
North Sunshine Dr. to South Sunshine Dr.	26	900
South Sunshine Dr. Bridge	42	1500
South Sunshine Dr. to Springer Rd.	25	900
Springer Rd. Bridge	23	800
Springer Rd. to 400 Springer Rd.	30	1100
400 Springer Rd Bridge	26	900
400 Springer Rd to Cuesta Ave.	42	1500
Cuesta Ave. Bridge	21	750

Cuesta Ave. to Arboleda Ave.	28	1000
Arboleda Ave. Bridge	23	800
Arbolida Ave. to Rosita Ave. (including 4 private bridges)	20	700

Reach Roughness Coefficient: 0.015

Typical Channel Photo



(April 11, 2002) Looking upstream – Permanente Creek Confluence to Rosita

Channel Description: Channel consists of concrete trapezoidal and concrete U-frame sections. Channel is in poor condition due to high level of invert scour, exposed re-bar, concrete spalling and popouts, and very significant wall deflection (in U-frame reaches).

Reach H-2: Rosita Avenue to Foothill Expressway (Sta 1+745 to Sta 2+930)

Channel Description: The channel alignment varies from straight to mild sinuous. The channel is natural with a simple trapezoidal configuration. Both banks are well-vegetated, with mature riparian trees and varying levels of undergrowth. Channel bottom sediment consists of sand and gravel.

Right-of-Way: Right-of-way is limited to the following sections:

46m section just upstream of Rosita Ave.; 13.4 to 22m (44-72ft); easement
61m section upstream of Rosita Ave.; 9m (30ft); fee
30m section downstream of Covington Rd.; 9m (30ft); easement
23m section upstream of Covington Rd.; 6 to 7.6m (20-25ft); easement
28m section downstream of Fremont Ave.; 9m (30ft); easement

Average Reach Slope: 0.0061

1% Flow: 31 cms (1100 cfs)

10% Flow: 19 cms (660 cfs)

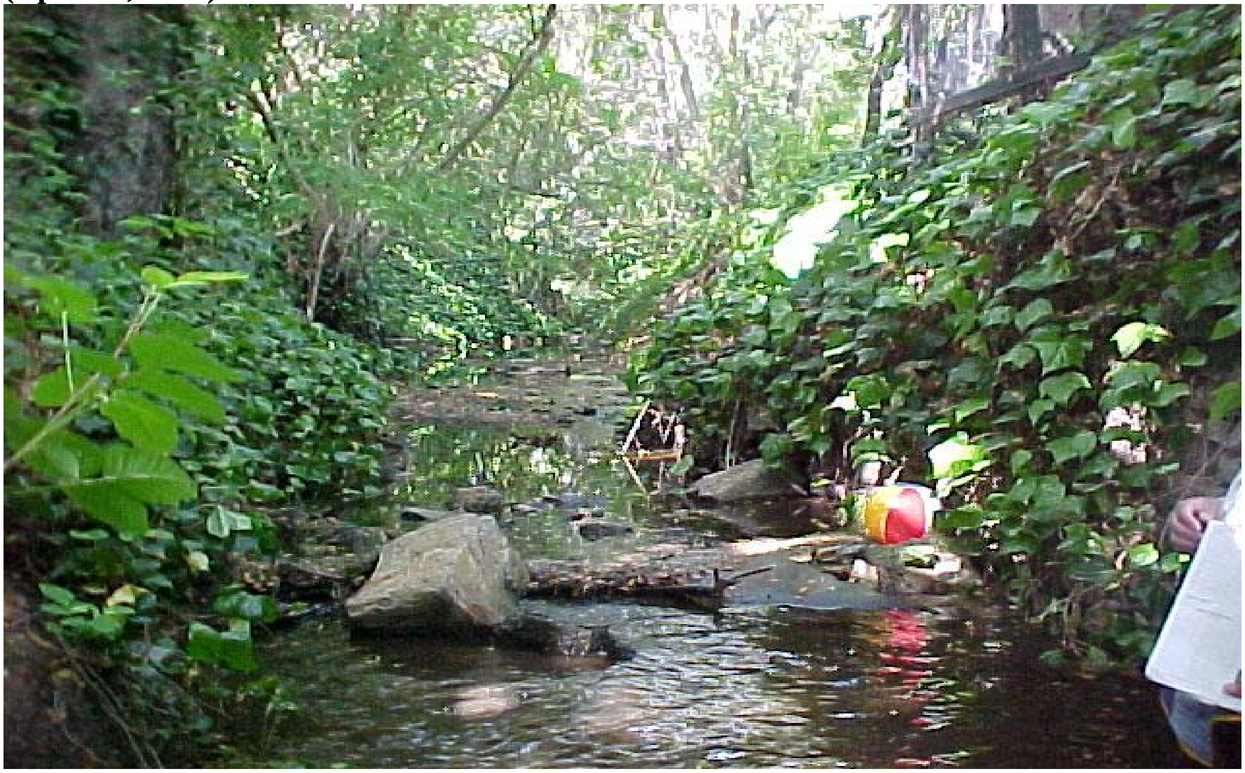
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
Rosita Ave. Bridge	23	800
Rosita Ave. to Rock Rip-Rap Section	15	550
Rock Rip-Rap Section	25	900
Rock Rip-Rap Section to Covington Rd.	15	550
Covington Rd. Bridge	10	350
Covington Rd. to Foothill Expwy.	11	400

Reach Roughness Coefficient: Composite channel roughness varies between 0.033 and 0.093

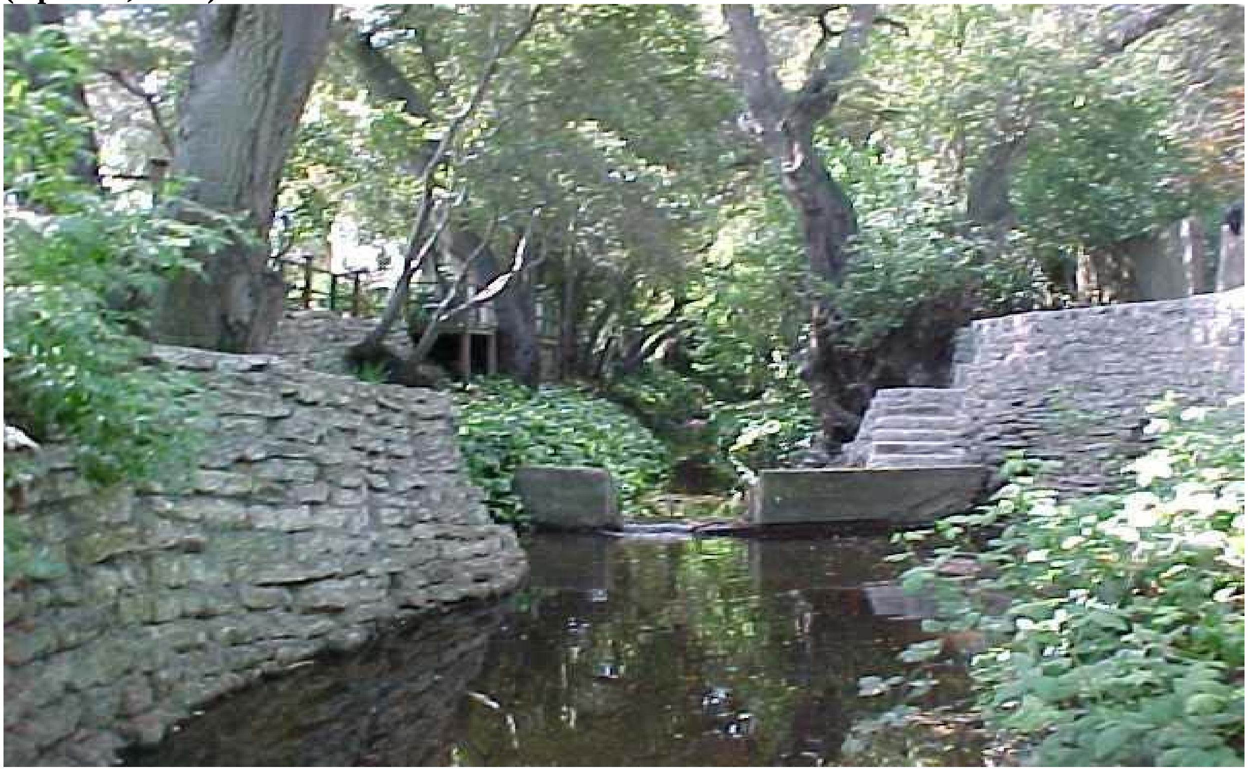
Typical Channel Photos: See the following pages for typical channel photos.

Hale Creek
(April 16, 2002)



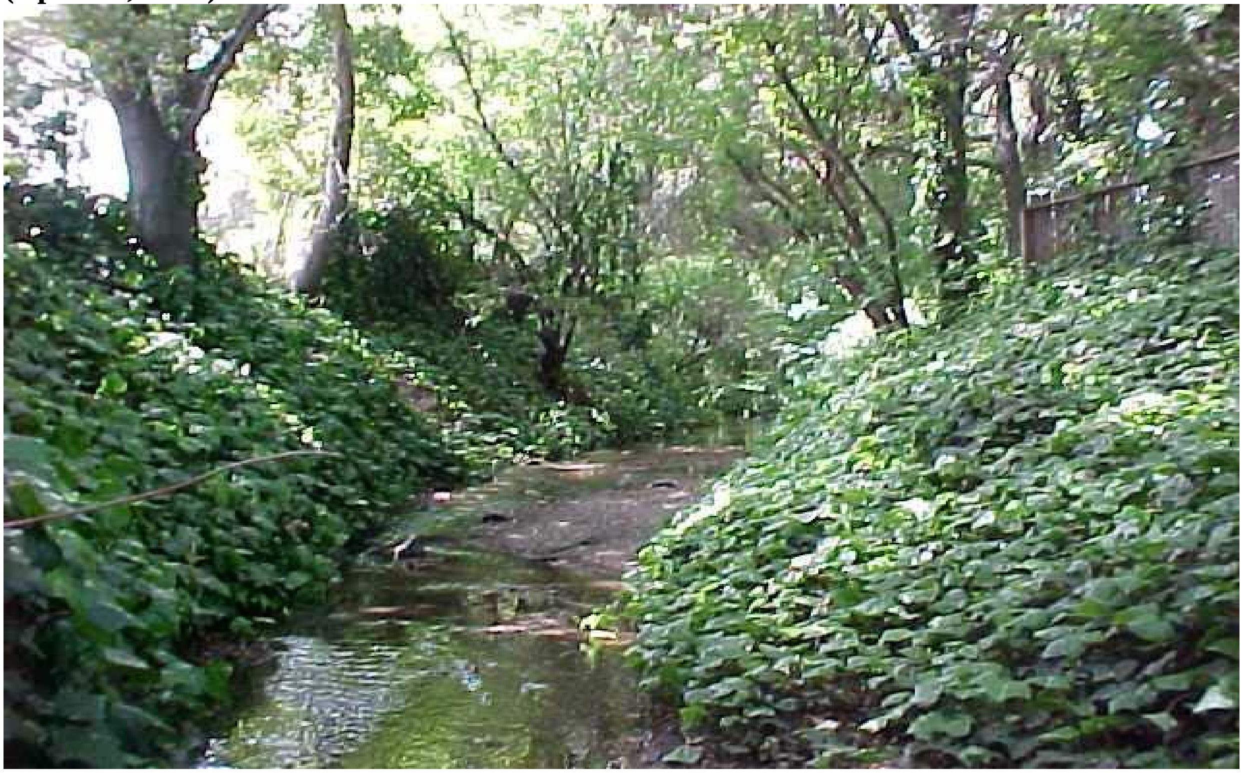
Location: Looking upstream – Rosita Ave. to Rock Rip-Rap Reach
Channel Description: Channel is natural, with a sinuous alignment. Channel is well-vegetated, with mature trees on both banks and limited understory. Channel bottom sediments consist of sand, gravel, and cobbles. Some spot bank protection (rock or sacked concrete) measures have been constructed in the past.

Hale Creek
(April 16, 2002)



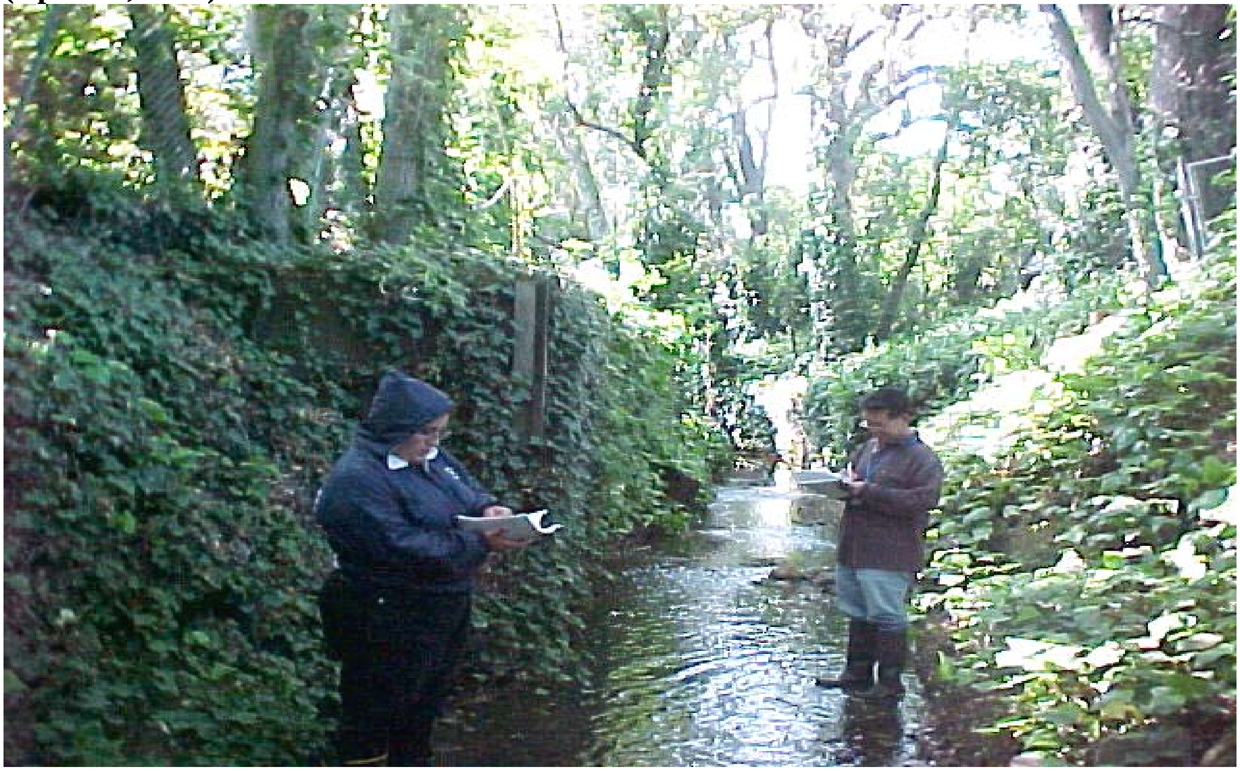
Location: Looking upstream – Rock Rip-Rap Reach
Channel Description: This short reach of the channel is lined by rock and stacked concrete. Work was done by the property owners.

Hale Creek
(April 16, 2002)



Location: Looking upstream – Rock Rip-Rap Reach to Covington Rd.
Channel Description: Channel is natural with sinuous alignment. Mature vegetation exists on both banks with limited understory. Channel bottom sediment consists of gravel and cobbles.

Hale Creek
(April 12, 2002)



Location: Looking upstream – Covington Rd. to Rixford Ln.
Channel Description: Channel is natural with sinuous alignment. Mature vegetation exists on both banks with limited understory. Channel bottom sediment consists of gravel and cobbles.

PERMANENTE DIVERSION

Reach PD: Stevens Creek to Permanente Creek (Sta 0+000 to Sta 2+168)

Channel Description: The channel is mostly a concrete trapezoid with minimal to no sediment and partly a larger concrete U-frame with some amount of gravel and sand deposition.

Right-of-Way: The right of way ranges from 17m (55 ft) to 18m (60 ft), consisting of fee and easement.

Average Reach Slope: 0.00385

1% Flow: 48 cms (1700 cfs)

10% Flow: 31 cms (1100 cfs)

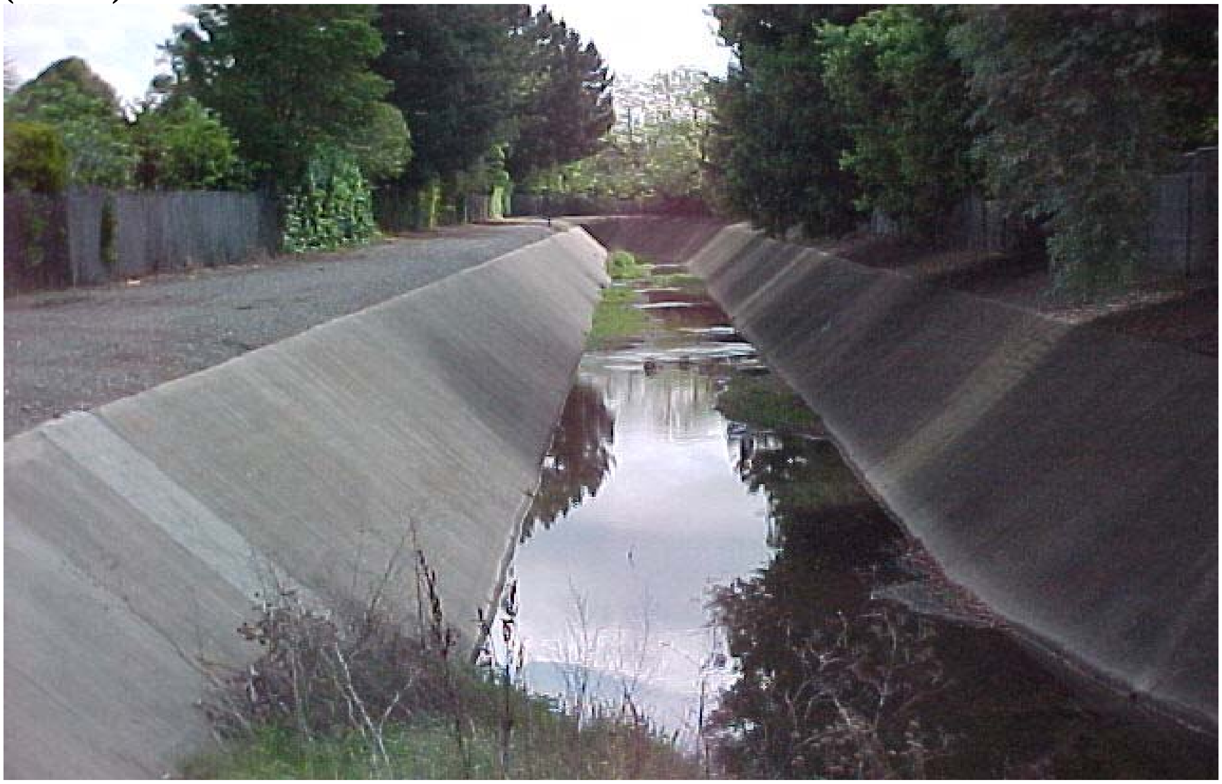
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
Grant Rd to Permanente Creek	40	1400
Grant Rd Bridge	105	3700
Diericx Dr to Grant Rd	68	2400
Diericx Dr Bridge	51	1800
Hwy 85 to Diericx Dr	113	4000
Hwy 85 Bridge	65	2300

Reach Roughness Coefficient: Composite channel roughness varies from 0.015 to 0.020

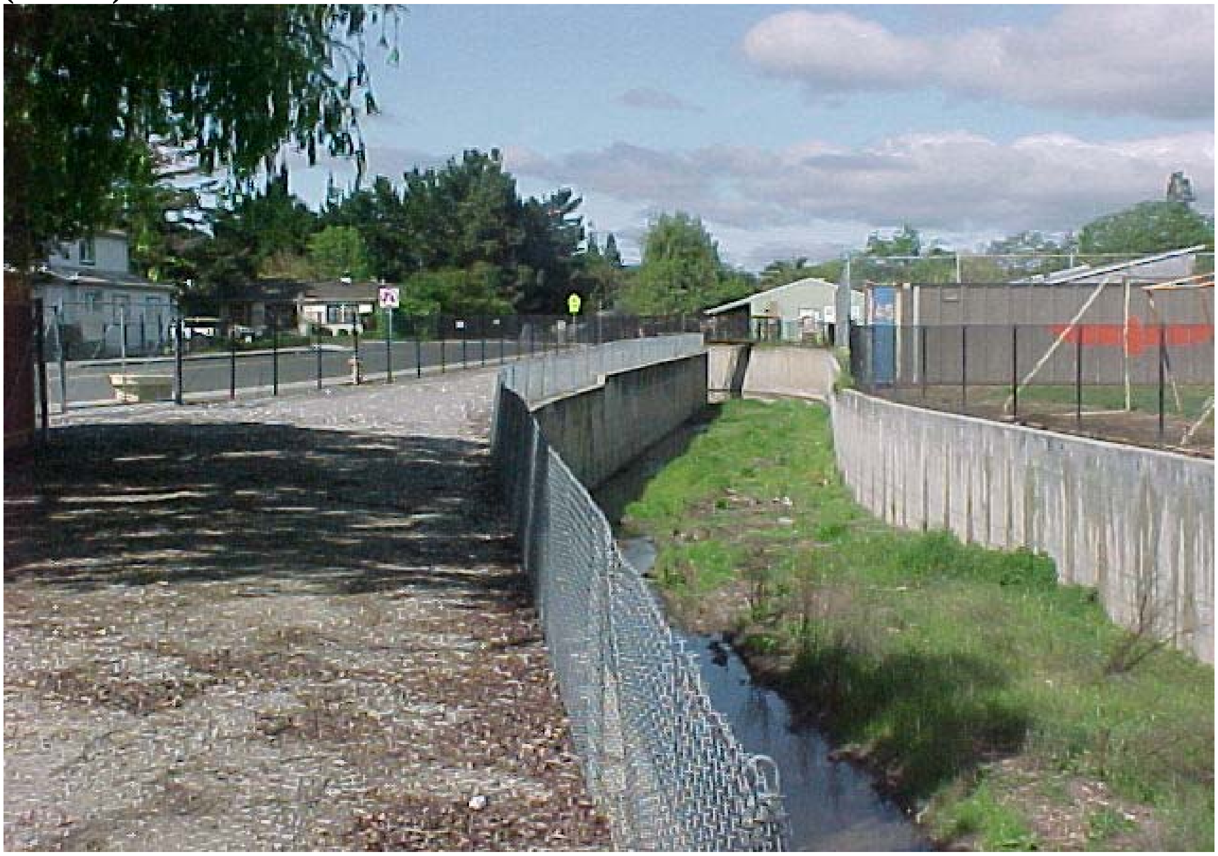
Typical Channel Photos: See the following pages for typical channel photos

Permanente Diversion
(4/10/02)



Location: Looking Downstream – Diversion to Grant Rd. (also typical of the channel reach from Grant Rd. to Stevens Creek)
Channel Description: Channel is trapezoidal concrete with a generally straight alignment, occasionally broken up by abrupt turns (see photo). The channel is in moderate to poor condition due to invert scour, exposed re-bar, concrete spalling and popouts. There is some minor sediment deposition.

Permanente Diversion
(4/10/02)



Location: Looking Upstream – Channel along Blach School (between Diversion and Grant Rd.)

Channel Description: Channel is U-Frame concrete and is somewhat sinuous. The channel is in good condition. This section experiences significant sediment deposition and requires regular sediment removal.

STEVENS CREEK

Reach SC: San Francisco Bay to the Permanente Diversion

Channel Description:

Downstream (SF Bay to Hwy 101):
The channel is a straight earth levee channel with East and West bank maintenance roads, a center island in the middle of the channel, and an East and West low flow invert on both sides of the island (see photo). East and West banks have a minimal quantity of grass. The center island is left natural and thus is well-vegetated with willows and a thick understory. Channel bottom sediments are silt and mud.

Midstream (Hwy 101 to Dana Avenue):
The channel is a straight earth channel with a trapezoidal shape. East and West banks have limited undergrowth and large, mature trees. Channel bottom sediments are sand, gravel, and small cobbles.

Upstream (Dana Avenue to Permanente Diversion):
The channel is a meandering natural trapezoidal channel. East and West banks have limited undergrowth and large, mature trees. Channel bottom sediments are sand, gravel, and medium sized cobbles.

Right-of-Way: Varies … see below

Reach Location	Right of Way (ft)		Fee (F) Easement (E) None (N)
	West Bank	East Bank	
Bay to Crittenden Lane	250	500	F & E
Crittenden Lane to Pedestrian Bridge	200	210	E
Pedestrian Bridge to La Avenida (1)	225	380	F
Pedestrian Bridge to La Avenida (2)	190	251	F & E
La Avenida to Hwy 101	75	280	F & E
Hwy 101 to Moffett	102	107	F & E
Moffett to Middlefield	50	50	F & E
Middlefield to Hwy 85	100	190	F & E
Hwy 85 to Central	66	75	F & E
Central to Evelyn	180	200	E
Evelyn to Dana	75	230	E
Dana to Hwy 85	40	110	E
Hwy 85 to Hwy 237	0	0	N
Hwy 237 to Yuba	0	0	N
Yuba to El Camino Real	0	150	F & E
El Camino Real to Hwy 85	0	200	F & E
Hwy 85 to Permanente Diversion	30	190	F & E

Average Reach Slope: 0.0064

1% Flow:
Stevens Creek at Highway 280 = 167 cms (5900 cfs)
Stevens Creek DS of Permanente Diversion = 227 cms (8000 cfs)
Stevens Creek at El Camino = 229 cms (8100 cfs)
Stevens Creek at Bayshore = 238 cms (8400 cfs)

10% Flow:
Stevens Creek at Highway 280 = 91 cms (3200 cfs)
Stevens Creek DS of Permanente Diversion = 130 cms (4600 cfs)
Stevens Creek at El Camino = 133 cms (4700 cfs)
Stevens Creek at Bayshore = 142 cms (5000 cfs)

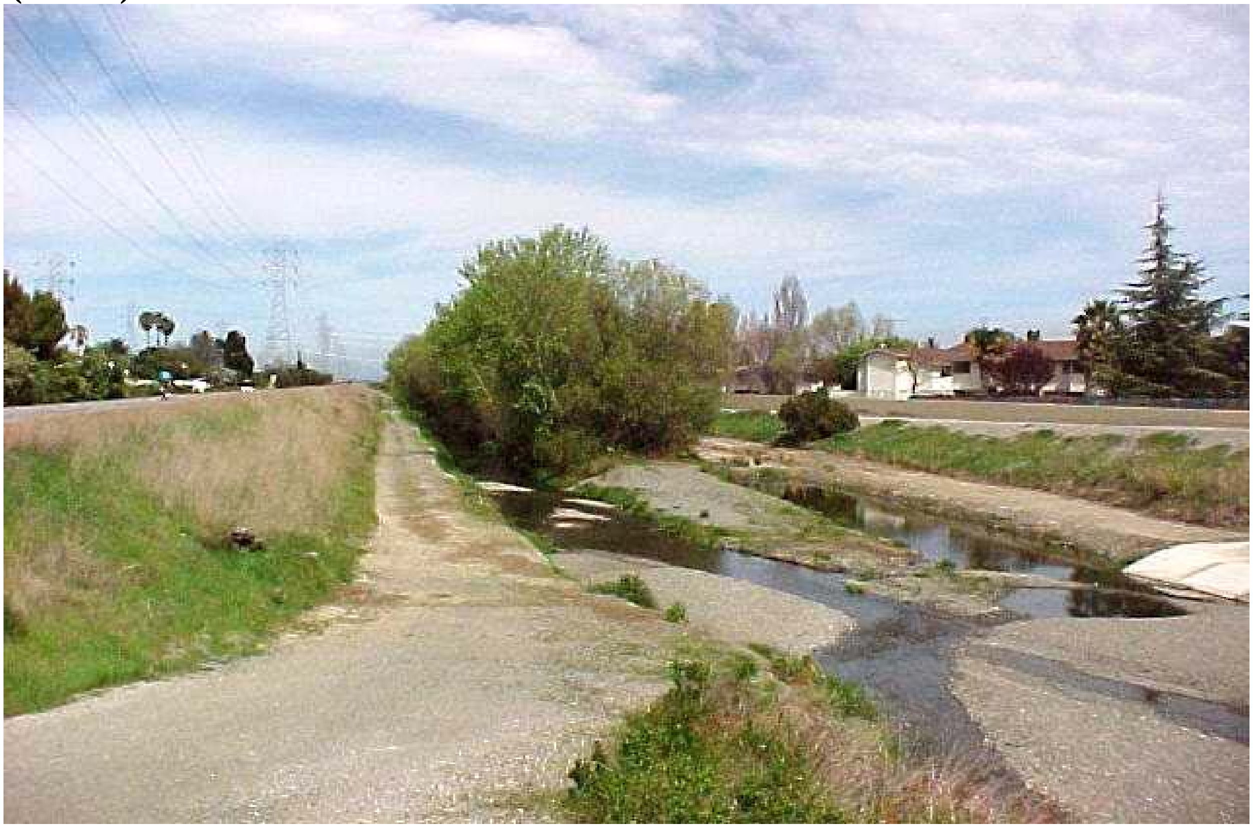
Current Reach Capacity:

Location	Capacity (cms)	Capacity (cfs)
SF Bay to Hwy 101	164	5800
Hwy 101 to El Camino Real	108	3800
El Camino Real to Permanente Diversion	> 227	> 8000

Reach Roughness Coefficient: Composite channel roughness varies from 0.020 to 0.068

Typical Channel Photos: See the following pages for typical channel photos.

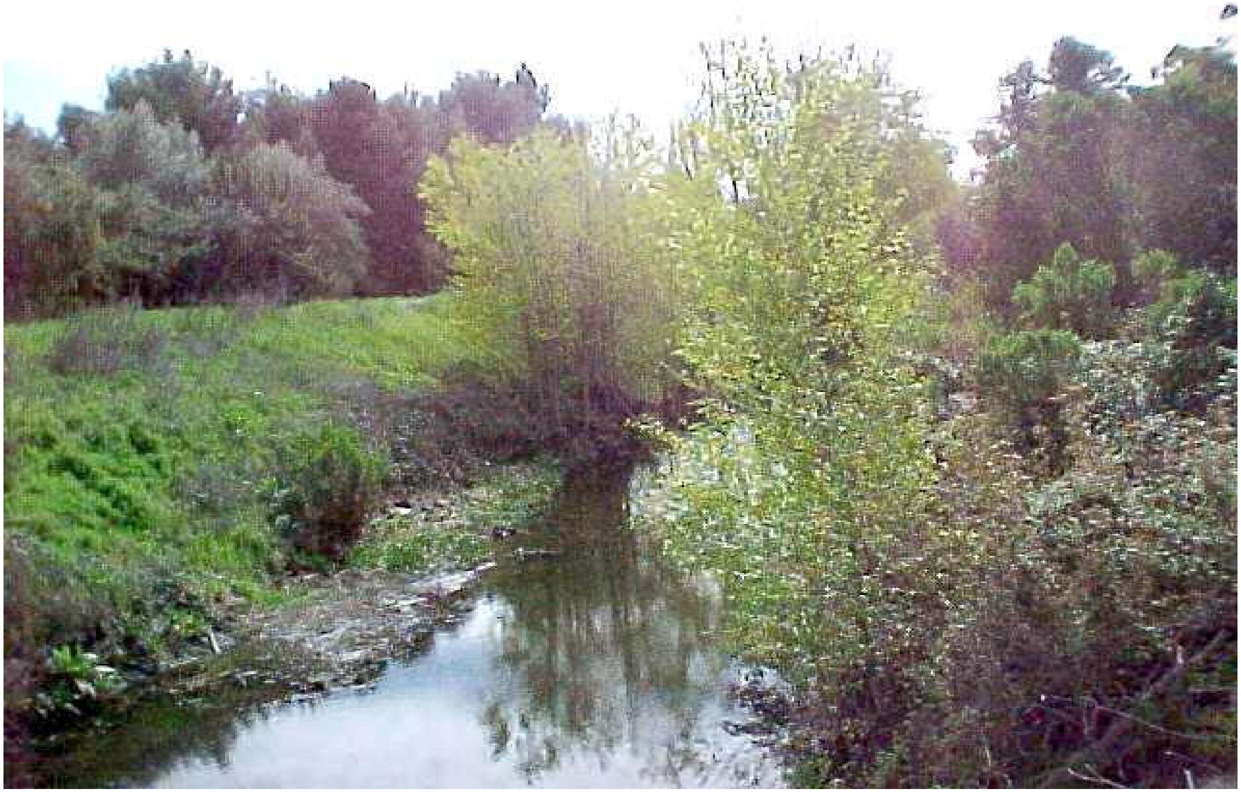
Stevens Creek
(3/11/02)



Location: Looking downstream - end of center channel island; between Crittenden Lane Bridge and Highway 101

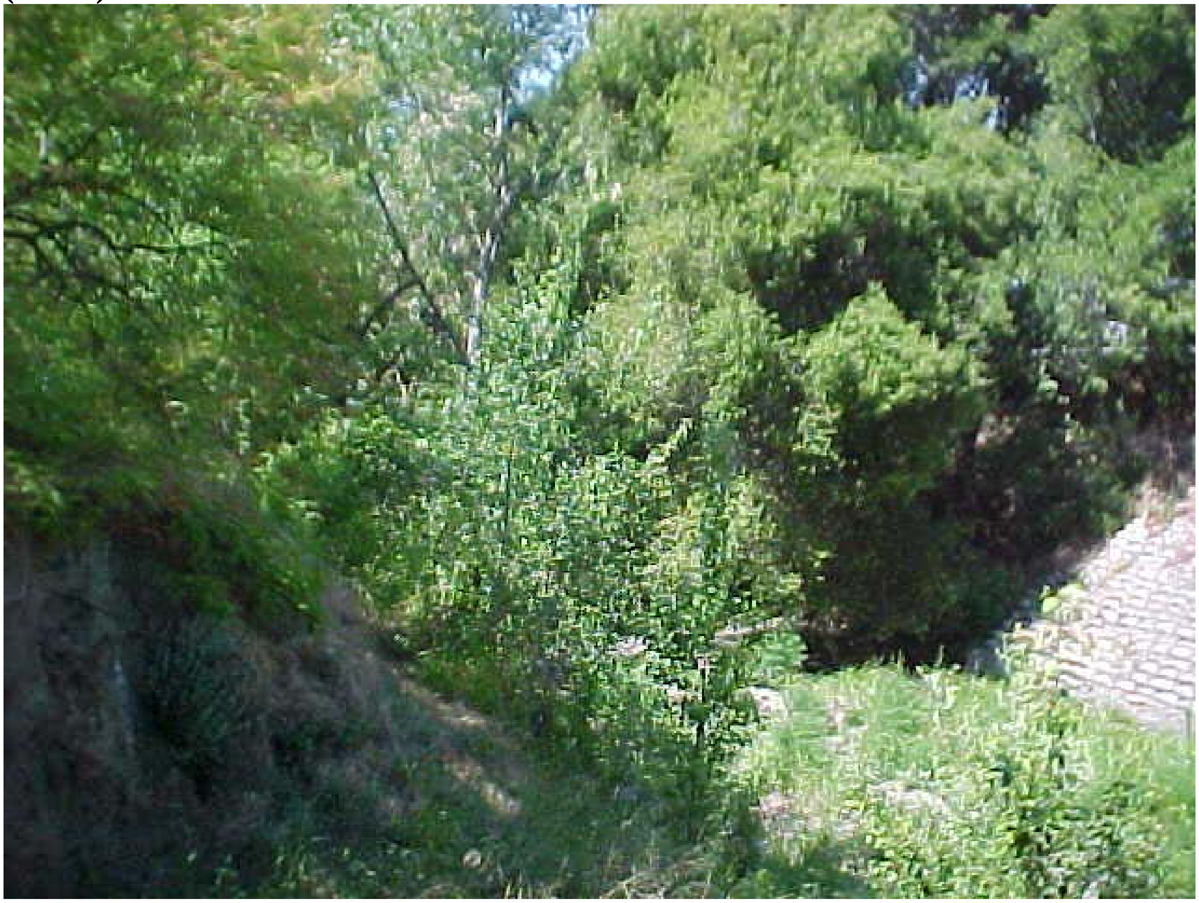
Channel Description: The channel is a straight earth levee channel with East and West bank maintenance roads, an island in the middle of the channel, and a low-flow channel on both sides of the island. The East and West banks have minimal quantity of grass. The center island has an intermediate quantity of brush. Channel material consists of silt and mud.

Stevens Creek
(3/11/02)



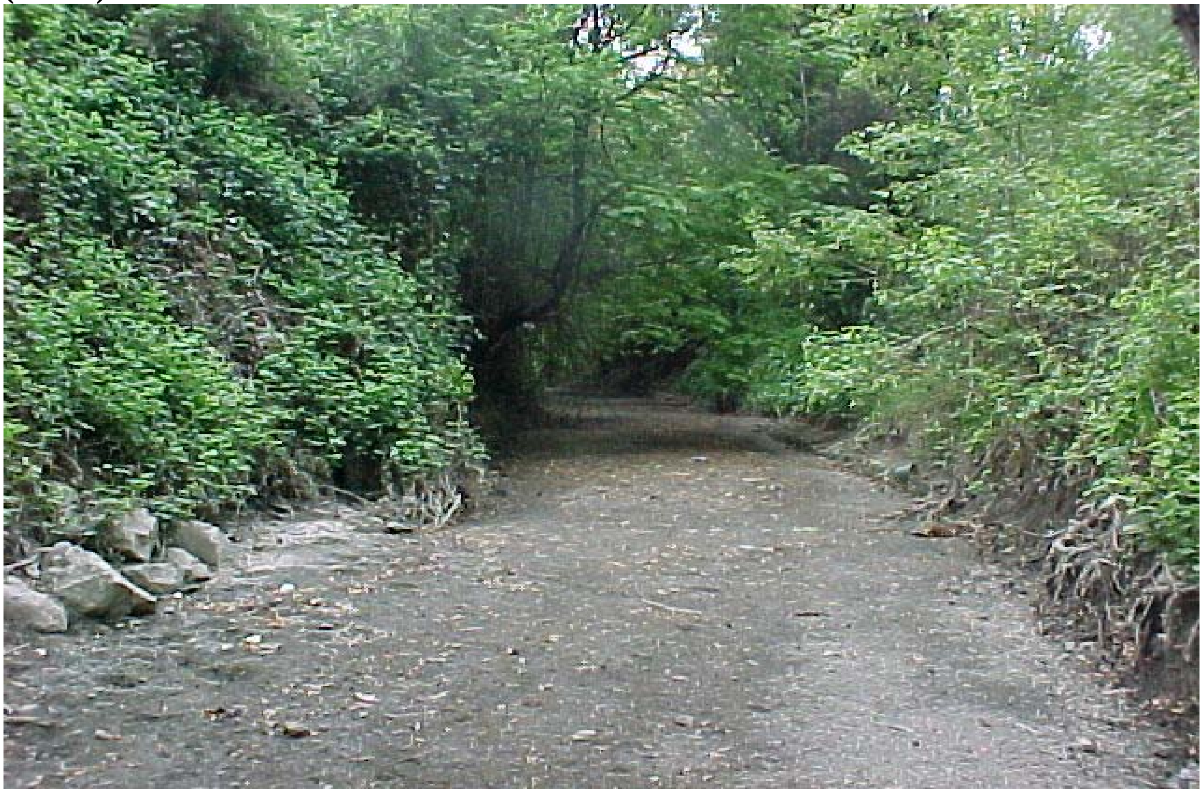
Location: Between Highway 101 and Moffett Boulevard
Channel Description: The channel is a straight earth channel of trapezoidal shape. East and West banks have limited undergrowth and mature trees. Channel materials consist of gravel and small cobbles.

Stevens Creek
(5/2/02)



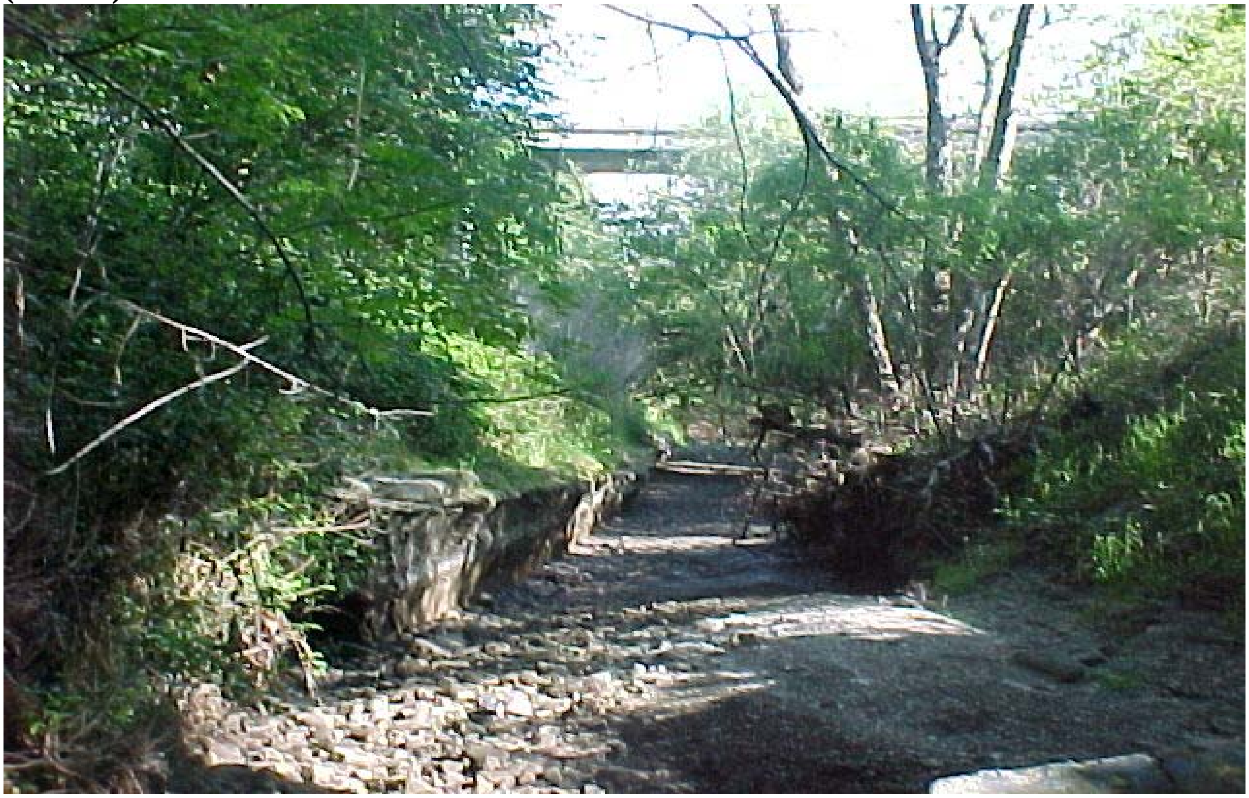
Location: Between Middlefield Parkway Bridge and Highway 85 Bridge
Channel Description: The channel is a straight, trapezoidal earth channel. The East and West banks have limited undergrowth and mature trees. Channel materials consist of gravel and small cobbles.

Stevens Creek
(4/9/02)



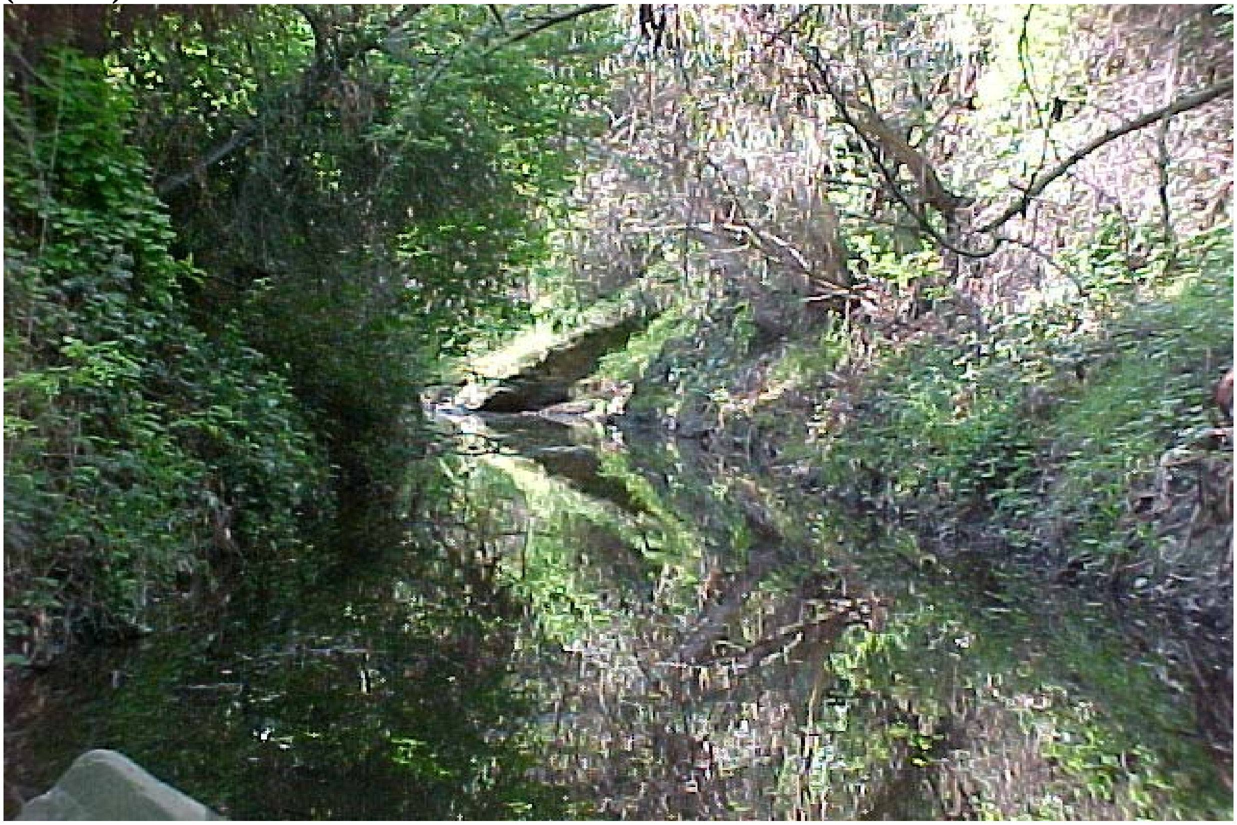
Location: Between Evelyn Avenue bridge to Dana Avenue bridge
Channel Description: The channel is a straight, trapezoidal earth channel. The East and West banks have limited undergrowth and mature trees. Channel materials consist of gravel and small cobbles.

Stevens Creek
(4/10/02)



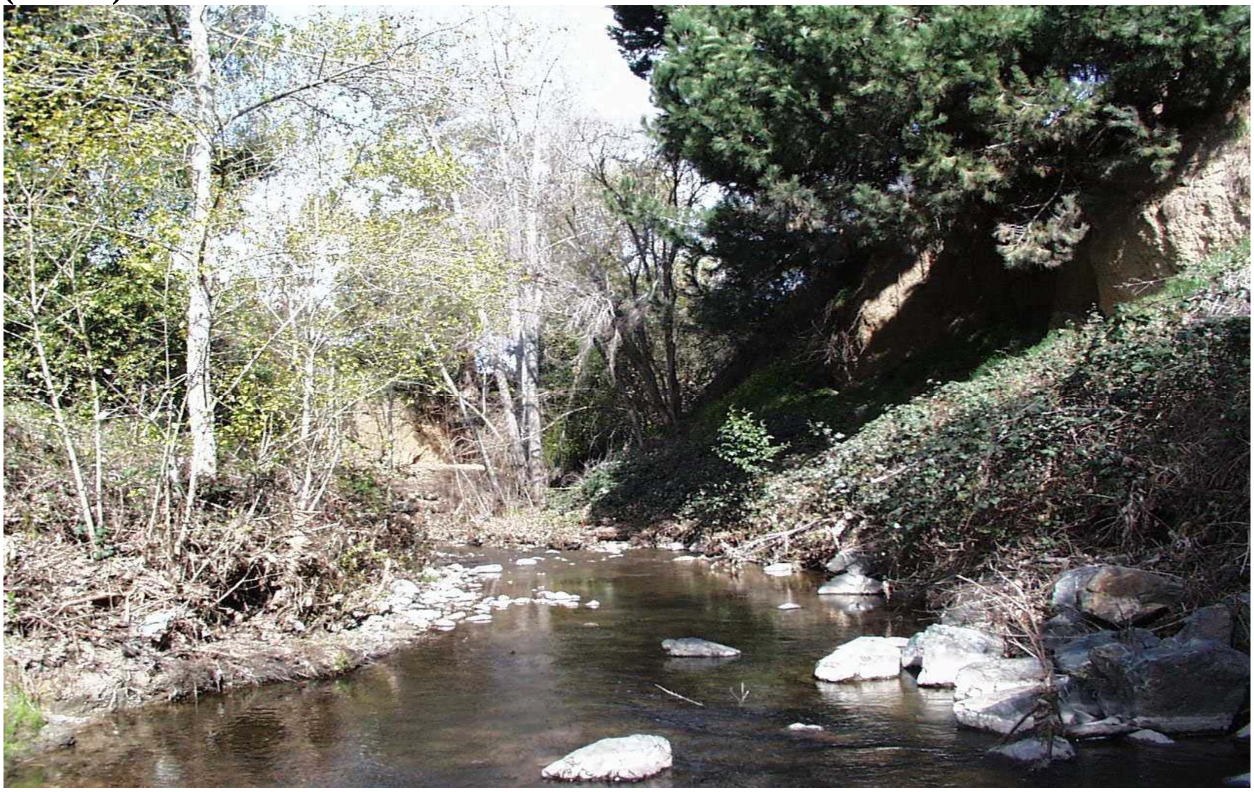
Location: Between Dana Avenue bridge to West-bound State Route 237 bridge
Channel Description: The channel is a meandering natural trapezoidal channel. The East and West banks have limited undergrowth and mature trees. Channel invert materials consist of sand, gravel, and medium-sized cobbles.

Stevens Creek
(4/10/02)



Location: Between El Camino Real Bridge to Highway 85 Bridge
Channel Description: The channel is a meandering, natural trapezoidal channel. The East and West banks have limited undergrowth and mature trees. Channel invert materials consist of sand, gravel, and medium-sized cobbles.

Stevens Creek
(3/11/02):



Location: Between Highway 85 and Permanente Creek Confluence

Channel Description: The channel is a meandering, trapezoidal natural channel. The East and West banks have limited undergrowth and mature trees. Channel invert materials consist of sand, gravel, and medium-sized cobbles.

C. Watershed Hydrology

Attachment 1 contains the hydrology report, which was prepared by SCVWD Hydrology Unit staff. The following are the current design flow values for the watershed:

Location	*Drainage Area (km^2)*	*Design 1% Flow (cms)*	*Design 10% Flow (cms)*
South-branch Permanente	10.8	48	27
Ohlone Creek	9.1	25	11
Permanente upstream of Hwy 280	19.9	71	37
Permanente upstream of Diversion	22.1	76	42
Permanente Diversion	-	48	31
Permanente upstream of Hale Creek	-	31	13
Hale Creek upstream of Permanente	11.1	31	19
Permanente downstream of Hale Creek	36.3	57	27
Permanente @ SPRR	40.9	62	31
Permanente @ Hwy 101	42.9	65	34
Stevens Creek downstream of Diversion	64.5	227	130
Stevens Creek @ El Camino Real	68.6	229	133
Stevens Creek @ Hwy 101	77.1	238	142

The design one-percent hydrographs are shown at various locations (see Figures 4, 5, 6, and 7). As can be seen, the peak of the hydrograph is very sharp; the peak of the design flood passes through the system in a matter of a few hours.

D. Watershed Physiography and Geology

The Permanente Creek watershed is one of several relatively moderate-sized drainages on the eastern slopes of the Santa Cruz Mountains and floor area of Santa Clara Valley in the northwestern portion of the county. It lies between the Stevens Creek drainage on the south and east and Adobe Creek drainage on the west. The headwaters originate near Black Mountain, approximately 850 meters (2,800 feet) above sea level, along Monte Bello Ridge. The main drainage flows southeasterly through the mountains and shifts to the north at the foothills. At an elevation of approximately 90 meters (300 feet), it emerges from the foothills into Santa Clara Valley, passing across the valley floor. Stream flows are ephemeral. Permanente Creek continues to flow north across the valley floor to San Francisco Bay. It is joined by Hale Creek, its principle tributary from the west, just south of El Camino Real. The headwaters of Hale Creek are in the foothills area within the Town of Los Altos Hills. Within the valley floor area both streams pass through the cities of Los Altos and Mountain View.

The natural drainage system has been altered for many reasons, including alterations to accommodate greater flood protection. These include (1) a cutting of a high water diversion channel within the valley floor eastward to Stevens Creek from a point above the confluence of Hale Creek and (2) the diverting of the mouth of the stream into San Francisco Bay from Charleston Slough eastward to Mountain View Slough. Stevens Creek, which originally

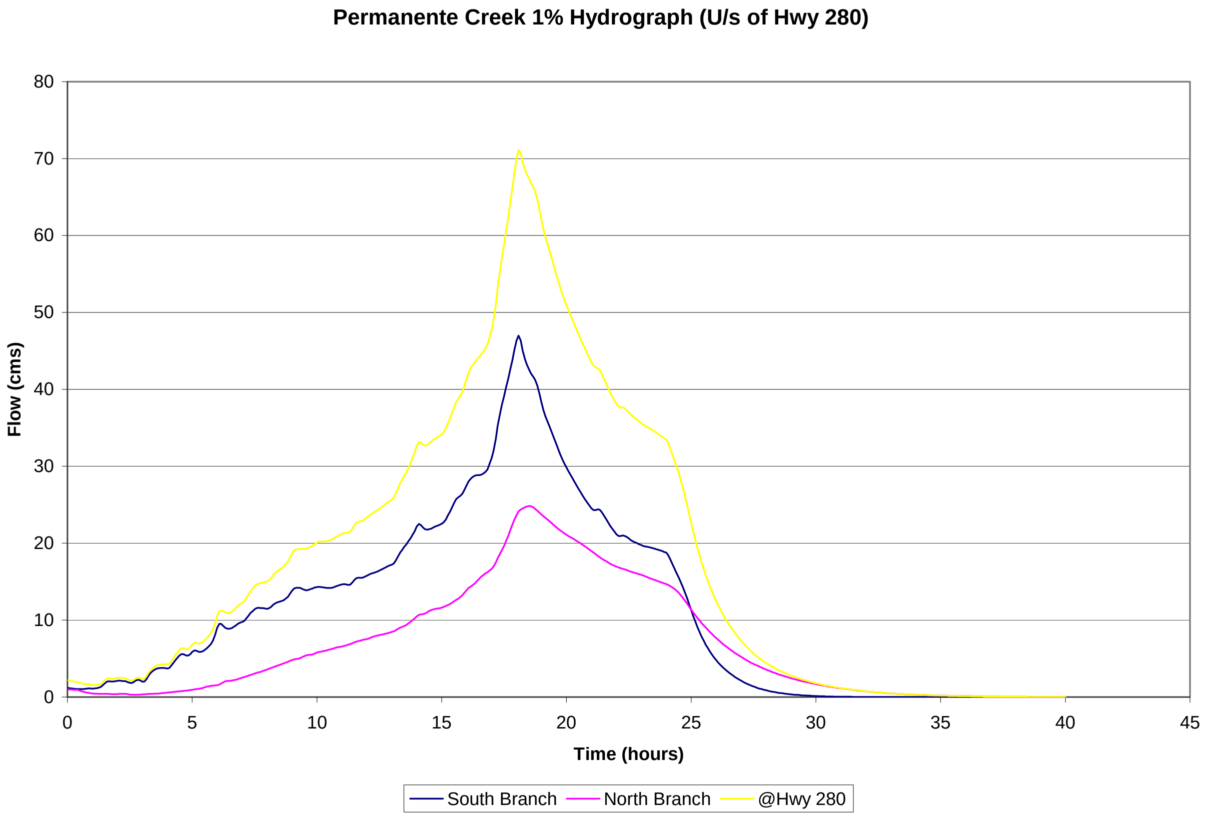

Permanente Creek 1% Hydrograph (U/s of Hwy 280)
Flow (cms)
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
Time (hours)
South Branch
North Branch
@Hwy 280

Figure 4

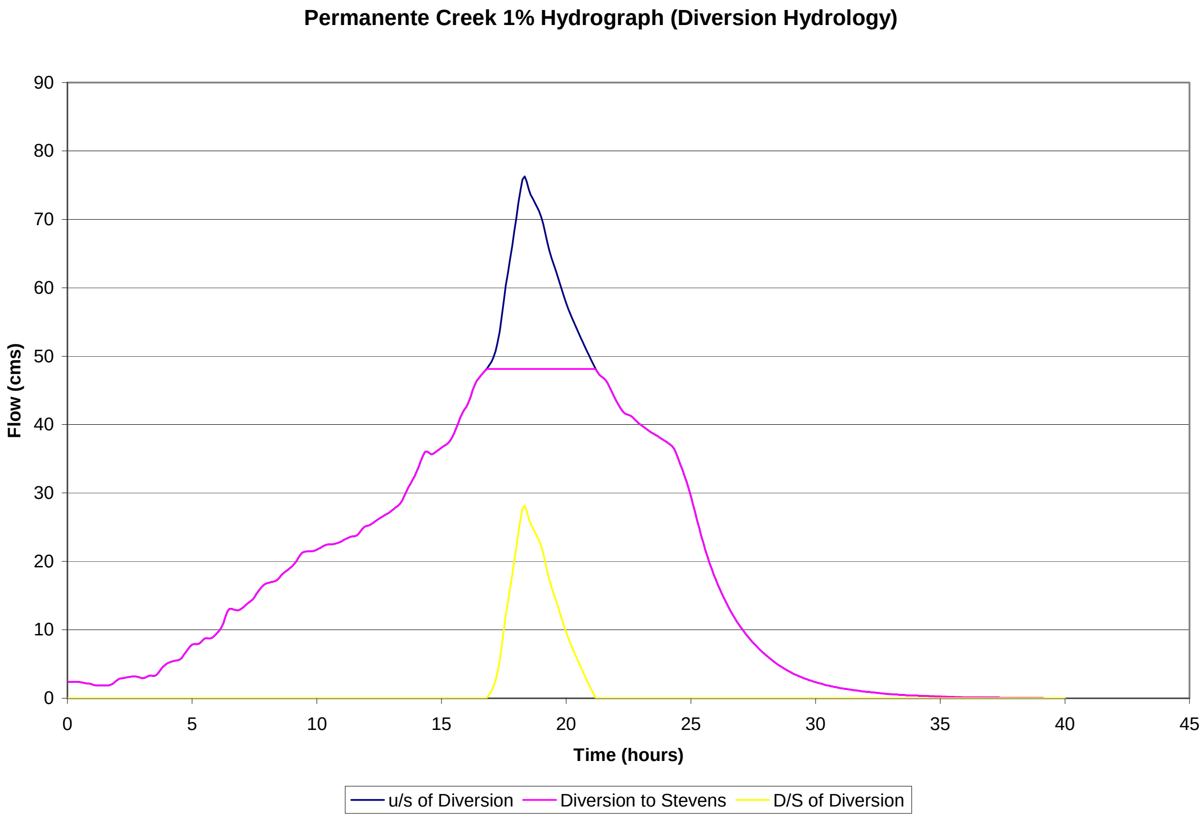

Permanente Creek 1% Hydrograph (Diversion Hydrology)
Flow (cms)
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
Time (hours)
u/s of Diversion
Diversion to Stevens
D/S of Diversion

Figure 5

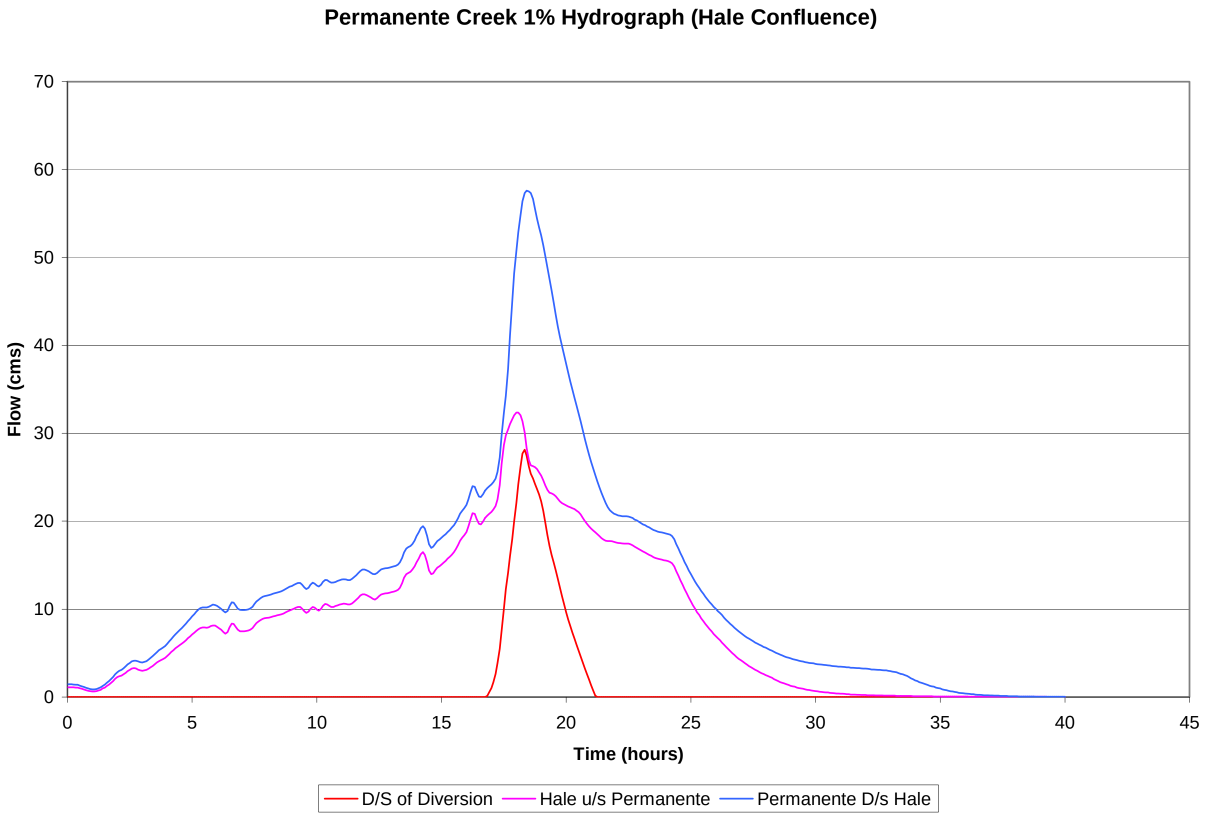

Permanente Creek 1% Hydrograph (Hale Confluence)
Flow (cms)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
Time (hours)
D/S of Diversion
Hale u/s Permanente
Permanente D/s Hale

Figure 6

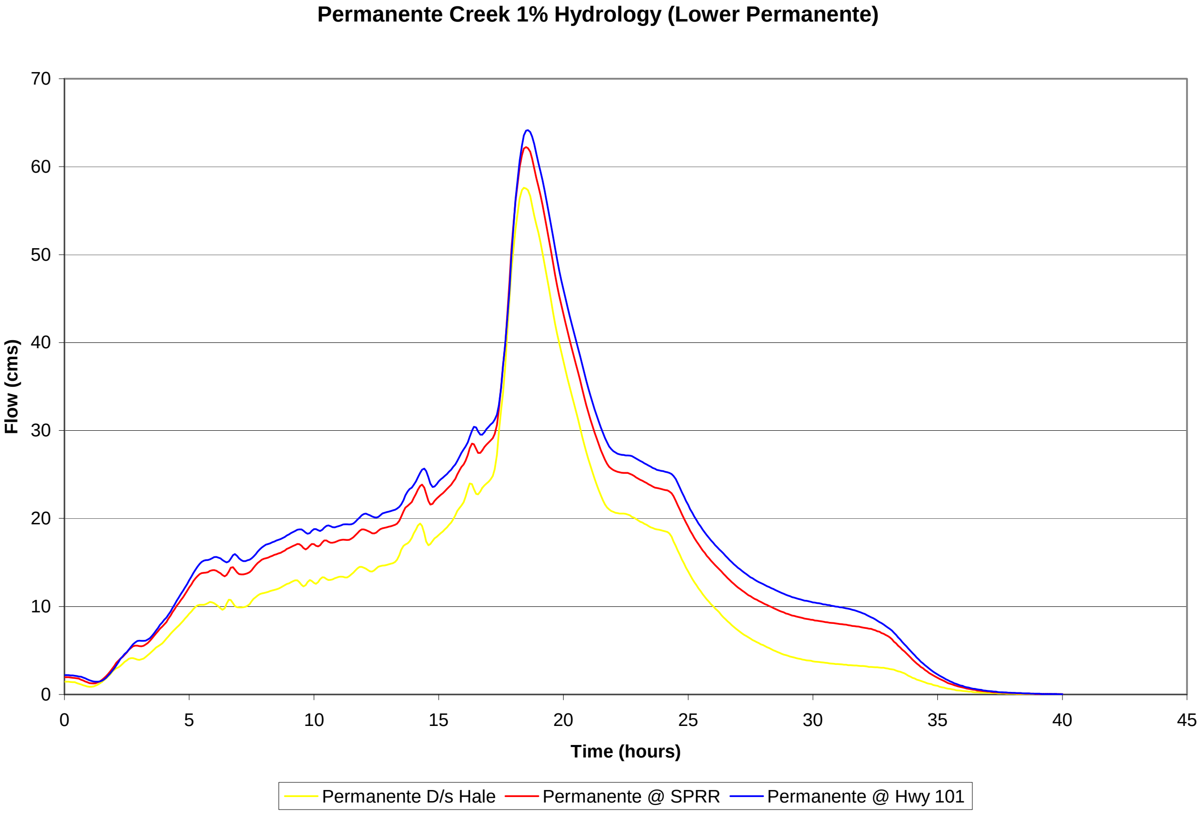

Permanente Creek 1% Hydrology (Lower Permanente)
Flow (cms)
0
10
20
30
40
50
60
70
Time (hours)
0
5
10
15
20
25
30
35
40
45
Permanente D/s Hale
Permanente @ SPRR
Permanente @ Hwy 101

Figure 7

entered the Bay at Mountain View Slough, was diverted eastward to form its new mouth at Whisman Slough.

Monte Bello Ridge, and most of the mountainous portion of the drainage, is underlain by the Franciscan Group of formations, a regional unit that forms much of the core of the Coast Ranges of California. The Franciscan Group consists of highly deformed, contorted, faulted, sheared and weathered sections of shale, sandstone, chert, limestone, and greenstone (metavolcanic rock). These were deposits as ancient sea floor sediments in a subduction zone where continental and oceanic plates were colliding on the crust of the earth. The colliding action, like sediments carried on converging conveyor belts, accounts for the intense deformation of the units. These were pervasively intruded by serpentine which is generally intensely sheared. The lower portion of the mountainous area is underlain by a narrow strip of northwesterly bedded tertiary shale of the Monterey Formation. These were deposited in inland seaways which invaded portions of the continent's edge during the Tertiary period (2 million to 65 million years ago). The foothills are underlain by gently and broadly folded claystone, sandstone, and conglomerate of the Santa Clara Formation. These are lightly consolidated to compacted and were deposited as alluvial outwash from the uplifting coast ranges during the Plio-Pleistacene epoch (10,000 years to 2 million years ago).

The older formations in the mountainous areas are cut by numerous ancient faults which are inactive. The closest active fault is the San Andreas fault which passes west of the watershed through the northwesterly trending Stevens Creek Canyon, just over the ridgeline of Monte Bello Ridge. The possibly active, northwesterly trending Monte Vista fault passes through the foothills of the watershed, forming a fault contact between the Franciscan Group on the southwest and the Monterey Formation on the northeast. This fault may be the northwesterly extension of the possibly active Shannon fault.

The valley floor area is underlain by young, unconsolidated alluvial fill washed down from the Santa Cruz Mountains. The upper elevated edge of the valley floor is underlain by alluvial fans, which splayed out from the mouths of streams emerging from the foothills and which have laterally coalesced with adjacent fans and contain relatively coarse sediments. Descending down the fan to its distal portion and onto the flat baylands, the surficial sediments become finer. They were deposited as basin, shallow marine and tidal deposits. The aggregation of unconsolidated sedimentary section beneath the valley floor, and including the subsurface portion of the Santa Clara formation beneath the young alluvial deposits, constitute the Santa Clara Valley groundwater basin. The maximum depth of the basin is in excess of 457 meters (1,500 feet). Groundwater in the basin may be unconfined (water table) or confined (under pressure). The pressure zone includes the deep aquifers within the basin areal interior.

The mineral quality of waters draining the mountainous and foothills area is expected to be a calcium bicarbonate to a calcium-magnesium bicarbonate type, ranging in total dissolved solids from about 150 to 350 milligrams per liter. Water of this concentration is suitable for most beneficial uses. The higher range of total dissolved solids concentration occurs at low flows when such flows are sustained by groundwater discharges from the bedrock and Santa Clara Formation. As the flows enter the valley, a certain amount infiltrates into the valley fill as natural ground water recharge. Beneficial recharge occurs in the elevated edges of the valley where the groundwater is unconfined and beyond the subsurface edges of the confined area. This area is known as the forebay of the basin. Along Permanente and Hale Creeks, the forebay extends from the foothills line to their confluence. Descending down the fan toward the baylands, the stream gradient flattens and the depth to groundwater beneath the stream is very shallow. Due to land subsidence, which created a local inland hydraulic gradient from the Bay, tidal water flows farther upstream across the subsided zone. This intrusion has caused the shallow aquifers beneath the bayfront area to become contaminated by salt.

Land use within the drainage varies. Large areas of the mountainous watershed are part of a limestone quarrying and Portland cement manufacturing operation. A portion below the cement operation is used for aluminum and chemical plant operation. Ranching is limited. Parts of the foothill areas are bare open lands with grassy sod cover and a limited amount of dry farming and other parts contain residential development. The watershed within the valley floor is covered by urban development except for a portion of the baylands which is covered by salt evaporation ponds adjacent to the Bay and by a municipal landfill in the baylands that has been landscaped for recreational use. Urban development consists of residential use in elevated portions of the valley floor, commercial and residential use toward the toe of the fan, and industrial use at the upper edges of the baylands.

E. Historical Stream Channel

Permanente Creek has been significantly changed by human activity. Some of these alterations in creek geometry and plan-form are so old that historical records of them do not exist. Maps from the 1876 Thompson & West Historical Atlas of Santa Clara County (see Figures 8 and 9) show that Permanente Creek had already been altered by that time. For example, an obviously straightened man-made channel had already been constructed downstream of the railroad tracks (SPRR) to carry flows from Permanente Creek into Charleston Slough.

The 1899 (reprinted in 1923) U.S.G.S. Topographic Palo Alto Quadrangle (portion shown as Figure 10) shows that the alignment of Permanente and Hale Creeks upstream of Fremont Avenue is very similar to the present day alignment. Between Fremont Avenue and El Camino Real, Permanente Creek followed the present day alignment with the exception of an area near Cuesta Drive where the original channel has natural meanders while the present day channel was straightened to align with Miramonte Drive. The map shows that Permanente Creek terminated upstream of the railroad tracks (near Central Expressway) and Hale Creek terminated upstream of Springer Road.

The 1948 U.S.G.S. Topographic Palo Alto Quadrangle shows that Permanente Creek was re-aligned downstream of the railroad tracks so that the creek closely follows its present-day alignment and discharges into Mountain View Slough. This map also shows Hale Creek terminating upstream of Springer Road. Thus, by the early 1940’s, the creeks were generally in their current alignment.

Figure 8 – Historical Map of Santa Clara County

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Figure 9 – Historical Map of Santa Clara County

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Figure 10 – Historical USGS Map Palo Alto Quad

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F. Land Subsidence

Over-drafting of the groundwater basin has caused land subsidence over the confined interior portion of the basin. Over-drafting refers to the process of extracting more water out of underground aquifers through pumping than is being replaced through percolation. The compressible layers of soil come under increased pressure as water pressure drops, causing the soil layers to reduce in width, which causes the general ground surface to drop. Land subsidence is a broad, gradual sagging of the surface that is usually hardly perceptible, except when it involves large hydraulic features such as creeks and pipelines. Subsidence in Santa Clara Valley began in the 1920's and generally ceased in 1969 when over-drafting was eliminated through the importation of water from the State Water Project.

Subsidence has led to collapse of well casings, and has had a significant impact on systems that rely on hydraulic gravity flow, such as sewer lines, storm drains, and creeks. Subsidence has caused bayfront lands in Santa Clara County to sink below sea level, enabling salt water to intrude upstream and dramatically affecting the riparian habitat. In addition, subsidence has increased the potential for tidal flooding.

Along Permanente Creek the greatest amount of subsidence was about 1.8 meters (6 feet), and was centered approximately where Highway 101 crosses the creek (see Figure 11 – Subsidence). The bayfront was depressed below sea level by a few feet. In order to protect the baylands from encroaching bay water over the subsided areas, a bayfront levee system had to be constructed. Stream channels flowing to the Bay had to have their levees raised in order to pass the flows through the subsided areas. Drainage waters accumulating behind the levees had to be pumped over the levees into the channels. The subtle alterations of the topography caused by land subsidence would also have the consequences of a net reduction of the natural flood flow carrying capacity of the stream channels in the downstream reaches.

III. Problem Definition

This section describes the currently identified problems in the project area and the history of attempts made to solve these problems.

A. Creek Flooding

Historical Flooding

The Permanente watershed has a history of recurring floods which have adversely impacted the safety and economic stability of the residents and businesses within the floodplain. Flooding within the Permanente watershed has been documented as far back as 1868. Flooding which has occurred on Permanente Creek, Hale Creek, and Permanente Diversion is described below.

Permanente Watershed - 1862. A flood of great magnitude occurred in 1862. Records of the flood are poor; however, it is reported that the flood of 1862 was larger in magnitude than the flood of December 1955.

Permanente Watershed - January, 1911. A large flood occurred in the watershed in January, 1911. Mr. R.E. Nordyke, a resident of the Hale Creek area, reported that "water flowed down Springer Road like a river". The January 20, 1911 Mountain View Register-Leader reported that "Saturday, January 14, 1911 goes down into history as a record breaking day for rainfall in Mountain View. The actual rainfall for that date was 4.60 inches, the greatest recorded in the history of Mountain View." (FEMA, 1980). Flood records are once again poor; however, it is reported that the flood of 1911 was larger in magnitude than the flood of December 1955.

Permanente Creek - February 1940. Several homes and some agricultural land in the vicinity of El Camino Real and Mountain View Avenue suffered light damage. Highways were also damaged and motorists were inconvenienced by the flooding.

Permanente Creek - November 1950. November flooding along Permanente Creek caused significant damage to agricultural and commercial properties. The following report ran in the November 20, 1950 Mountain View Register-Leader: "Swollen by the heaviest rains in 32 years, Permanente Creek burst its banks . . . and sent torrents of muddy water rushing into Mountain View streets, causing thousands of dollars of damage to merchandise in El Camino stores. . . Countless other thousands of dollars of damage was done to orchard land along Miramonte Road by the swirling waters as tons of precious top soil were swept away in the flood" (FEMA, 1980).

Permanente Creek - January 1952. Flooding along Permanente Creek caused significant damage to properties in Los Altos and Mountain View. The January 14, 1952 Mountain View Register-Leader reported that "Mountain View's new sewage plant was nearly under water, the El Camino Real underpass to Highway School was cut off to traffic, six homes on Springer Road were isolated, an office on El Camino and a house on Grant Road were inundated, . . . and navy pump crews prevented lapping waters from flowing into buildings at Moffet Homes" (FEMA, 1980). Flooding also occurred near San Ramon Ave., San Luis Ave., Middlefield Rd., and at the intersection of El Camino Real and El Monte Ave.

Permanente Creek and Hale Creek- December 1955. One of the greatest storms in modern times in Santa Clara County occurred in December 1955, the so-called "Christmas Storm." Most of the flooding occurred in the lower reaches of Permanente Creek where approximately 770 acres were inundated with floodwaters. Flooding near El Camino Real and Highway 101 was reported. During the flood, downed trees and debris blocked culverts and caused the creek to overtop its banks. Residential homes, agriculture, and commercial business in Mountain View and Los Altos sustained losses. Salt ponds at Mountain View Slough suffered extensive losses due to the flow of fresh water into the ponds. Several bridges and culverts in Mountain View were extensively damaged and eroded. Approximately 100 people residing in lowland areas were evacuated from their homes for a period of two weeks as a result of the flooding.

Figure 11 – Subsidence Map

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The Mountain View Register-Leader reported that Police, Fire, and City crews were called on ". . . to battle swollen Permanente Creek and flooded streets fed by rains which poured into the area without letting up" (FEMA, 1980).

At Hale Creek, water overtopped the creek's banks near Marilyn Dr., Rosita Ave., Covington Drive, and Mountain View Avenue. Flooding in this area was reported to be up to 1 foot deep. Significant flooding is also reported to have occurred in the upstream portion of the watershed, in the vicinity of Magdalena Ave. and Hillview Rd.

Damages in the Permanente watershed totaled at $142,500 in 1955 dollars.

Permanente Creek - April 1958. In 1958, flooding occurred along both the upper and lower reaches of Permanente Creek. Flooding in the upper reaches was confined to areas near the creek. Water overtopped the banks at several locations and flooded streets, sidewalks, and yards in Los Altos and Mountain View (U.S. Army Corp of Engineers; June, 1959). In the lower reaches of the creek, flooding was more severe. Flooding is reported to have occurred near Middlefield Road, Barbara Road, El Camino Real (to a depth of 2 feet), and in downtown Mountain View near Evelyn Ave. and Franklin St. (to a depth of 1 foot). Flooding in the vicinity of Bayshore Highway resulted in significant damage to both residential and agricultural properties.

Damages in the Permanente watershed were totaled at $95,200 in 1958 dollars.

Permanente Watershed - January 1963. Minor street flooding occurred in the Permanente watershed in January 1963.

Permanente Watershed - January 1968. Minor street flooding occurred in Mountain View and Los Altos due to 1.48 inches of rain which fell within a 24 hour period.

Permanente Diversion - March 2, 1983. On March 2, 1983, Permanente Diversion overtopped its banks and flooded Blach Jr. High School to a depth of 1/2 foot. Street flooding also occurred, as well as minor mud damage to the garages of three homes on Altamead Drive.

The flooding was related to operations conducted at the Kaiser Cement Plant located in the upper Permanente Watershed. Immediately after the flood, Kaiser staff reported that the outlet to a large water "retention structure" had become plugged. On March 2, the plug burst, which resulted in the release of a large slug of water to Permanente Creek. County Communications reported that a large (about 20-foot deep) "wall" of water was observed traveling down Permanente Creek from Kaiser Cement. (Internal District memo, April 29, 1983) When the slug of water reached the box culvert near Blach Jr. High School, the water overtopped the banks. The capacity of the box culvert was significantly reduced due to sediment which had accumulated within the culvert.

Permanente Creek and Hale Creek - January 1995. The storm of January 9-10, 1995, resulted in flooding on Permanente and Hale Creeks. Permanente Creek overflowed its banks causing damage to two units of an apartment building on Park Drive in Mountain View. The flood water in the apartments rose to a level of about 2 feet, and also inundated the adjoining garage, driveway, and a parking area. Hale Creek overbanked at Covington Road in Los Altos, resulting in street flooding.

Permanente Creek and Hale Creek - February 1998. The storms of February 2 though February 7, 1998 resulted in over-banking of the west levee of Permanente Creek, immediately downstream of Amphitheater Parkway in the City of Mountain View. Floodwaters just barely spilled over the bank and into an empty lot adjacent to the creek. Permanente Creek also overtopped its banks just upstream of Park Avenue; minor flooding of a parking lot occurred.

During the storm of February 2-3, 1998, Hale Creek overflowed its banks at Covington Road, Rosita Avenue, Arboleda Drive, and at the intersection of Mountain View Avenue and Raymundo Avenue. This resulted in minor street flooding.

See Figure 12 for a map of the most recent flood locations.

Current Flooding Problems

Although it is impossible to determine the exact location of future flood events, potential flooding problems along Permanente Creek, Hale Creek, and Permanente Diversion can be identified by mapping the one-percent flood.

The one-percent flood is the standard design flood for the District. The one-percent flood is defined as a flood that has a one percent probability of occurrence in any given year. The one-percent flood does not necessarily happen once in a hundred years; it can occur in consecutive years or even twice in the same year.

Permanente Creek Watershed

For the Permanente Creek watershed, Figure 13 depicts the areas subject to flooding from a one-percent event occurring in the creek. This map is based on Flood Insurance Studies (FIS) sponsored by Federal Emergency Management Agency (FEMA). Figure 14 shows the areas subject to flooding based on the District’s definition of flooding. The major difference between the two flood mappings is that the District considers areas that experience flood depths of less than 0.3 meter (1 foot) as being flooded, while FIS maps only consider greater than 0.3m flooding in their flood maps.

Numerical models of Permanente and Hale Creeks and the Permanente Diversion show that, in total, 2474 parcels encompassing 706 acres of land would currently be subject to flooding from a 1 percent flood.

Figure 12 – Recent Flooding History

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Figure 13 – FEMA Floodplain

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Figure 14 – Water District Floodplain Map

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Permanente Creek and Permanente Diversion Flooding:

The following is a comparison of the current capacity versus one-percent flow for various reaches of Permanente Creek in the project area. Reaches that do not have one-percent capacity are highlighted in red.

Location	1% Flow (cms)	Current Capacity (cms)
San Francisco Bay to U/S end of Salt Ponds	65	26
Salt Ponds to Boat Pond	65	30
Boat pond Bridge	65	35
Boat Pond to Shoreline	65	148
Shoreline Parkway Bridge	65	100
Shoreline to Rengstorff	65	100
Rengstorff Walkway Bridge	65	100
Rengstorff to Golf Course	65	57
Golf Course Bridge	65	64
Golf Course to New Ditch	65	66
New Ditch Bridge	65	44
New Ditch to Amphitheater	65	43
Amphitheater Parkway Bridge	65	131
Amphitheater to Charleston	65	44
Charleston Road Bridge	65	73
Charleston to Hwy 101	65	40
Highway 101 Bridge	62	42
Hwy 101 to Old Middlefield	62	40
Old Middlefield Way Bridge	62	27
Old Middlefield to Rock	62	52
Rock Street Bridge	62	35
Rock to Middlefield	62	58
Middlefield Road Bridge	62	38
Middlefield to San Ramon	62	65
San Ramon Avenue Bridge	62	37
San Ramon to San Luis	62	40
San Luis Avenue Bridge	62	51
San Luis to Montecito	62	50
Montecito Avenue Bridge	62	43
Montecito to Hackett	62	53
Hackett Avenue Bridge	62	55
Hackett to Hetch Hetchy	62	57
Hetch Hetchy Bridge	62	27
Hetch Hetchy to Central	62	31
Central Expressway Bridge	57	33
Central to SPRR	57	92
SPRR Bridge	57	38
SPRR to Villa	57	28

Location	1% Flow (cms)	Current Capacity (cms)
Villa Street Culvert	57	34
Villa Culvert to El Camino Culvert	57	34
El Camino Real Culvert	57	34
El Camino Real to Private Bridge	57	36
Private Bridge	57	36
Private Bridge to Park	57	36
Park Drive Bridge	57	28
Park to Mountain View	57	18
Mountain View Avenue Bridge	57	21
Mountain View to Hale Creek Confluence	57	18
Hale Creek Confluence to Marilyn	31	10
Marilyn Drive Bridge	31	8
Marilyn to Barbara	31	6
Barbara Avenue Bridge	31	7
Barbara to Miramonte/Cuesta	31	8
Miramonte/Cuesta Culvert	31	12
Miramonte/Cuesta to Villa Siena	31	16
Villa Siena Bridge	31	17
Villa Siena to St. Francis Walkway	31	19
St. Francis Walkway Bridge	31	25
St. Francis Walkway to St. Francis Exit	31	25
St. Francis Exit Bridge	31	25
St. Francis Exit to St. Francis Entrance	31	27
St. Francis Entrance Bridge	31	20
St. Francis Entrance to Abandoned Bridge #30	31	25
Abandoned Bridge #30	31	40
Abandoned Bridge #30 to Abandoned Bridge #31	31	35
Abandoned Bridge #31	31	23
Abandoned Bridge #31 to Covington	31	16
Covington Road Bridge	31	14
Covington to 54” Diversion Pipe	31	9
54” CMP (note: pipe regularly clogs with sediment)	31	6
Diversion to Gage	76	48
Gage Bridge	76	159
Gage to Portland	76	82
Portland Avenue Bridge	76	59
Portland to Aura	76	27
Aura Way Bridge	76	90
Aura to Fremont	76	134
Fremont Avenue Bridge	76	182
Fremont to Foothill	76	172

Permanente Diversion Flooding:

Location	1% Flow (cms)	Current Capacity (cms)
Hwy 85 Bridge	48	65
Hwy 85 to Diericx	48	113
Diericx Drive Bridge	48	51
Diericx to Grant	48	68
Grant Road Bridge	48	105
Grant to Permanente Creek	48	40

In summary, most sections of Permanente Creek and one part of the Permanente Diversion do not currently have one-percent flood protection. This flooding is not caused by a few culverts or isolated channel reaches; rather, almost the entire stretch of the project area, open channel, as well as bridges and culverts, currently cannot pass the one-percent flows. Note that this is under "current" condition modeling, which assumes no requirement for freeboard and assumes no further degradation of the channel. For future conditions modeling, the capacities will be lower still.

Hale Creek Flooding:

The following is a comparison of the current capacity versus 1 percent flow for various reaches of Hale Creek in the project area:

Location	1 % Flow (cms)	Current Capacity (cms)
Permanente Creek to Mt. View	31	56
Mt. View Avenue Bridge	31	22
Mt. View to Arroyo	31	22
Arroyo Road Bridge	31	52
Arroyo to Marilyn	31	35
Marilyn Drive Bridge	31	35
Marilyn to 7th Day Adventist	31	41
7th Day Adventist Bridge	31	18
7th Day Adventist to North Sunshine	31	26
North Sunshine Drive Bridge	31	18
North Sunshine to South Sunshine	31	26
South Sunshine Drive Bridge	31	42
South Sunshine to Springer	31	25
Springer Road Bridge	31	23
Springer to 400 Springer	31	30
400 Springer Road Bridge	31	26
400 Springer to Cuesta	31	42
Cuesta Avenue Bridge	31	21
Cuesta to Arboleda	31	28
Arboleda Avenue Bridge	31	23

Location	1 % Flow (cms)	Current Capacity (cms)
Arbolida to Rosita (including 4 private bridges)	31	20
Rosita Avenue Bridge	31	23
Rosita to Rock Rip-Rap Section	31	15
Rock Rip-Rap Section	31	25
Rock Rip-Rap Section to Covington	31	15
Covington Road Bridge	31	10
Covington to Foothill Expressway	31	11

Similar to Permanente, most sections of Hale Creek do not currently have one-percent flood protection. The flooding is not caused by a few culverts or isolated channel reaches; rather, almost the entire stretch of the project area, open channel, as well as bridges and culverts, currently cannot pass the one-percent flows. Again, this is under current conditions.

Stevens Creek Flooding:

Because the Permanente watershed is related to the Stevens Creek watershed through the Diversion, Stevens Creek downstream of the Diversion was also analyzed for flood capacity. The following is a comparison of the current capacity versus one-percent flow for various reaches of Stevens Creek downstream of the Diversion:

Location:	1 % Flow (cms)	Current Capacity (cms)
San Francisco Bay to Highway 101	238	164
Highway 101 to El Camino Real	229	108
El Camino Real to Permanente Diversion	227	227

As can be seen from above, Stevens Creek currently does not have sufficient capacity to carry the one-percent flow (even with zero freeboard).

B. Maintenance Access

In order to maintain the creek, maintenance staff must be able to access the creek. Access to Hale Creek, and access to Permanente Creek upstream of Highway 101 is difficult, costly, and often severely limited because the District holds a very narrow maintenance easement along the creeks.

Downstream of Highway 101, maintenance roads located on the top of the levees provide access to most of Permanente Creek. Since crews and equipment can operate on the top of the levees, out of the creek bed, access to the creek is generally possible year-round. Along Hale Creek, and along Permanente Creek upstream of Highway 101, there are no maintenance roads; creeks are generally accessed at bridge crossing. In order to maintain the creek between bridges, equipment must be moved along the bottom of the creek bed, which typically prohibits maintenance of these areas during periods of medium and high flows. In most areas where the creeks flow through concrete channels, vehicular access is possible during periods of low flows by driving along the invert of the creek. In areas were the creeks are in a semi-natural state, no vehicular access is possible.

A brief description of existing maintenance access for each section of Permanente and Hale Creeks within the project study area is presented below.

Permanente Creek

Reach P1: San Francisco Bay to south boundary of Salt Ponds

Maintenance access is poor; the levees are owned by US Fish and Wildlife Service and vegetation is not regularly controlled to allow for vehicular access.

Reach P2: South Boundary of Salt Ponds to Highway 101

Maintenance access to this area is available along maintenance roads located on the tops of the levees.

Reach P3: Highway 101 to Villa St.

Maintenance ramps located at several locations allow maintenance vehicles access to the creek during periods of low flow. During periods of medium and high flows there is limited access to the creek because maintenance crews cannot move along the bottom of the channel.

Reach P4: Villa St. to El Camino Real

Maintenance ramps allow limited access to the downstream end of the Villa St. culvert and the upstream end of the California/El Camino culvert during low flows. There is no access to the remainder of the culvert, with the exception of a few drop inlets.

Reach P5: El Camino Real to Confluence with Hale Creek

This section can be accessed only by a maintenance ramp located at Mountain View Avenue. During periods of medium and high flows there is limited access to the creek because maintenance crews cannot move along the bottom of the channel.

Reaches P6 and P7: Confluence with Hale Creek to Confluence with Permanente Diversion

There is very little access for maintenance vehicles along these entire reaches. Access is limited to the areas next to Miramonte Avenue.

Reach P8: Confluence with Permanente Diversion to Foothill Expwy

Maintenance ramps allow access to the invert of the creek in the downstream portions of the reach; however, vehicular access may be impaired by drop structures. There is little access in the upstream portion of the reach.

Hale Creek

Reach H1: Confluence with Permanente Creek to Rosita Ave.

Maintenance ramps located at several locations allow maintenance vehicles access to the creek during periods of low flow. During periods of medium and high flows there is limited access to the creek because maintenance crews cannot move along the bottom of the channel.

Reach H2: Rosita Avenue to Foothill Expressway

There is very little access for maintenance vehicles along the entire reach other than at bridge crossings.

Permanente Diversion

Reach PD: Stevens Creek to Permanente Creek

Maintenance ramps located at several locations allow maintenance vehicles access to the creek during periods of low flow. During periods of medium and high flows there is limited access to the creek because maintenance crews cannot move along the bottom of the channel. There is some top of bank room available.

C. Water Quality

Creek water quality problems may typically be due to the following causes:

- Agricultural Activities
- Commercial and Industrial Activities
- Mining Activities
- Erosion of creek banks and invert
- Leaking underground storage tanks / Hazardous material spills
- Land alteration for development
- Urban storm water runoff

Some of these issues are sources that contribute to water quality problems in the Permanente Creek watershed. The water quality problems created by these activities include the following:

- Pollution of underground public water resources
- Degradation of habitat for native flora and fauna
- Loss of property
- Increase in channel maintenance in order to maintain creek flow capacity

Level I Hazmat Analysis

A Level I hazardous materials investigation was conducted for the District by D&M Consulting Engineers in 2001. A copy of the executive summary of the report is included as Attachment 2. The investigation discovered the following possible issues of concern:

Alignment 1: Both banks of Permanente Creek from Salt Ponds to Middlefield Road

Issues of potential concern: Regional volatile organic compound (VOC) plumes that have widely impacted groundwater and surface water, golf course lawn chemical use, a gasoline ground water plume beneath the Jones Hall US Army Reserve Center, and possible historic spills at an adjoining machine shop and auto repair facility.

Alignments 2 and 3 were related to tidal flooding.

Alignment 4: Both sides of Permanente Creek from Middlefield Road to Foothill Expressway

Issues of potential concern: fuel oil spill on residential property at 395 Sierra Vista Drive, pesticides impacting soil at 465 Sierra Vista Drive, and possible historic spills at former dry-cleaning, painting, and gas station businesses on neighboring properties.

Alignment 5: Hale Creek from Confluence with Permanente to Foothill Expressway

Investigation did not reveal any known or suspected conditions.

Alignment 6: Permanente Diversion from Permanente Creek to Stevens Creek

Issues of potential concern: possible historic spills at former greenhouses or packing plants adjoining the alignment on the South.

The results of the Level I investigation indicate that further investigation may be required, depending on the alignment of the work sites. Level II work would be conducted if the preferred plan involves activities in the areas identified by the Level I analysis.

Sedimentation

Due to the shearing effects of the highly active local fault zones, creeks originating in the Santa Cruz Mountains typically have high amounts of natural sediments associated with high volume flow events. In addition to this natural background level sediment production, three factors increase sedimentation in the Permanente/Hale watersheds.

Hanson Permanente Cement Plant

The plant operates on the southern fork of the upper Permanente watershed. The mining activities generate tremendous amounts of “waste rock”, which are stored on site, sometimes in very close proximity to the creek. The activities also produce smaller sand particulates and dust, which can be carried to the creek during storm events.

In response to concerns from the public and regulatory agencies such as the Regional Water Quality Control Board (RWQCB), the plant has devised various methods to trap the waste materials and dust from being carried into the creek. These methods include interception ponds, flow diversion from work sites, in-stream sediment catch basins, etc. The plant reports annually to the RWQCB on how they are meeting their storm water pollution prevention plan (SWPPP) goals.

Urbanization

Urbanization also causes increased sediment production in Santa Clara Valley. Urbanization causes dramatically more rapid and higher peaks in creeks for the more frequent flows (1- to 10-year events). The higher flows cause a response in natural channels, which classically consists of down-cutting (getting deeper) and then bank erosion (getting wider) to be able to handle the increased flows. During this channel adjustment period, which can occur over decades even if urbanization has been completed, the deepening and widening creates much higher than normal sediment loads for downstream sections.

The other effect of urbanization is to route road deposits such as metals and petroleum products into storm drains and thus into the receiving waters. This issue has previously been identified as a source of pollution to both creeks and the southern San Francisco Bay.

Tidal Sedimentation

In the reaches of Permanente Creek subject to tidal influence (approximately up to Hwy 101), tidal sedimentation is a maintenance concern. Generally, the process for tidal sediment creation involves waves in the shallow southern sections of San Francisco Bay stirring up very fine sediments (bay mud) from the bottom of the Bay. The diurnal tides carry this sediment up the various creek channels. As the tides turn, the flow velocity drops to near zero, and a small amount of sediment can deposit on the channel bottom. These sediments would generally wash away during severe winter events; however, the sediments tend to attract saltwater marsh vegetation, such as tulles, which stabilize the sediments in place. Sedimentation in the tidal sloughs thus tends to occur inward from the banks.

Sedimentation Locations

Significant sediment deposition has historically occurred at two locations in the Permanente watershed: 1) on Permanente Creek near Highway 101; and 2) in the Permanente Diversion and in Permanente Creek immediately upstream of the Diversion. Minor sedimentation problems also occur along Hale Creek and its tributaries.

Significant sedimentation problems in the Permanente Watershed are described below.

Permanente Creek - San Francisco Bay to Highway 101

Significant sediment deposition occurs along the lower reach of Permanente Creek from the San Francisco Bay upstream to Highway 101.

In South San Francisco Bay, a large percentage of the fine sediments found in tidal reaches are transported from the Sacramento Delta down to the South Bay where the sediments are deposited in areas sheltered from waves and tidal currents (Krone 1972). Most of the sediment removed from Permanente Creek downstream of Highway 101 consists of fine clays and silts, and it is therefore likely that tidal action is responsible for the majority of sedimentation downstream of Highway 101.

Periodic sediment removal between Amphitheater Parkway and Highway 101 has been performed by the District in order to increase the carrying capacity of the creek and minimize the threat of flooding. Between May 1979 and May 1998, sediment removal was conducted on seven different occasions between Amphitheater Parkway and Highway 101. A total of 3,640 cubic meters (4,758 cubic yards) of sediment have been removed over the 19 year period; the average volume of sediment removed from this area is 190 cubic meters (250 cubic yards) per year. Sediment removal data is presented in Figure 15.

Permanente Diversion and Permanente Creek near the Diversion

Significant sediment deposition also occurs along Permanente Diversion and along Permanente Creek immediately upstream and downstream of the Diversion. This sediment has been transported downstream from the upper portion of the Permanente watershed. Sediment deposition occurs along the Diversion due to the mild slope of the channel.

Sedimentation also occurs in the 54-inch culvert on Permanente Creek which crosses under Eastwood Drive. The pipe is located just downstream of the beginning of the Permanente Diversion Channel. The Diversion was designed so that the base flows would be carried by Permanente Creek, and higher flows would be carried by the Diversion. However, heavy sediment deposition within the 54" culvert has repeatedly blocked it and prevented flows from traveling down Permanente Creek.

District maintenance staff reports that one or two large storms are enough to completely fill the culvert with sediment and block all flows through it. Removing the sediment from the culvert has proved to be very difficult and costly. Due to these problems, the District's present mode of operation is to close the gate to the 54" culvert every year between October 15 and April 15, in order to minimize sediment deposition in it.

Periodic sediment removal along Permanente Diversion and Permanente Creek (between Eastwood Drive and Portland Avenue) has been performed by the District in order to maintain the capacity of the creek and minimize the threat of flooding. Between May 1979 and May 1998, sediment removal was conducted on 22 different occasions along Permanente Diversion and Permanente Creek between Eastwood Drive and Portland Avenue. A total of 35,000 cubic meters (45,800 cubic yards) of sediment have been removed over the 19 year period, the average volume of sediment removed from this area is 1840 cubic meters (2,410 cubic yards) per year.

Sediment removal data is presented in Figure 16. Note that the bar graph in Figure 16 shows that very little sediment removal occurred from the mid 1980's through 1991. This period coincides with a drought in Santa Clara County. Decreased stream flows typically result in decreased sedimentation and erosion; therefore, it is likely that the drought contributed to the reduced need for sediment removal during this period.

Hale Creek and Tributaries

Sedimentation occurs along Hale Creek and its tributaries; however, the rate of sedimentation is much less than the upper reaches of Permanente Creek. Between May 1979 and May 1998 there is only record of a single sediment removal activity, which occurred (outside of the project reach) on Magdalena Creek in 1988.

Bank Erosion

Within the Permanente watershed study area there is significant erosion in many of the semi-natural earthen channels. There are four stretches of semi-natural earthen channels within the study area: Permanente Creek from San Francisco Bay to Highway 101; Permanente Creek from the Hale Creek confluence to the Permanente Diversion Channel; Permanente Creek from Portland Avenue to Foothill Expressway, and Hale Creek from Rosita Avenue to Foothill Expressway.

Permanente Creek - San Francisco Bay to Highway 101

Minor levee erosion occurs in the area at several outfalls.

Permanente Creek - Hale Creek Confluence to Permanente Diversion Channel

Some erosion of the creek banks occurs throughout this reach. The creek channel is very narrow, and is highly encroached upon by surrounding residential properties. Bank slopes are typically steep. In many areas the slopes approach vertical.

Numerous patchwork attempts at bank stabilization have been made in this area by the District and by private parties. Bank stabilization methods used in this area include sacked concrete, wooden retaining walls, and concrete rubble and rock retaining walls.

Permanente Creek - Portland Ave. to Foothill Expressway

Some erosion of the creek banks occurs throughout this reach. Although the creek bed is significantly wider in this reach than in the downstream reaches, the channel is very deep and the banks are steep.

There is scattered use of sacked concrete in this reach, especially at creek bends along the outside bank. In several areas the toe of the sacked concrete has become undercut by invert erosion.

Figure 15 – Sediment Removal (Lower Permanente Creek)

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Figure 16 – Sediment Removal (Permanente Diversion)

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Hale Creek - Rosita Ave. to Foothill Expressway

Significant erosion of the creek banks occurs throughout this reach. In the reach, the creek channel is narrow and the bank slopes are steep. The creek is highly encroached upon by residential properties.

Numerous patchwork attempts at bank stabilization have been made in this area by private parties. Bank stabilization methods used in this area include sacked concrete, wooden retaining walls, concrete rubble, and rock retaining walls.

D. Structural Deterioration

The Permanente Diversion was constructed in 1959 and most of the remaining concrete channel work was completed in the early 1960's (see Figure 17 – Channel Types). Engineering projects are built with assumed life spans, although many perform their intended service far longer than planned. Permanente Creek and Hale Creek, however, have definitely deteriorated, to the point that some reaches are in severe risk of failure.

A structural study of the channels was commissioned in 1999. The structural engineering firm of Biggs Cardosa Associates conducted a thorough study of the current condition of the channels, predicted future performance, and recommended certain possible rehabilitation or replacement options. The Executive Summary of their report is Attachment 3.

The study found that much of the work conducted in the 1960's has deteriorated and significant lengths of the constructed channels are in danger of failure. The failure mechanisms vary, with the most worrisome being vertical banks toppling into channels.

The study also developed a mechanism for estimating the remaining service life for the channels (See Figure 18 – Remaining Service Life). A small percentage of channel length was thought to be in danger of imminent failure; but the majority of channel length was determined to be in high risk of failure during the next 15 years (from 1999).

E. Incorrect Flow Split at Diversion

Due to poor design, the 54" culvert (which represents Permanente Creek) does not function as intended at the point of the diversion to Stevens Creek. The inlet to the culvert (at the bottom of the channel) as well as the culvert itself are severely prone to sedimentation and are extremely difficult to restore once silted in. To avoid this problem, the culvert is screened off from flows every winter, in effect making the diversion to Stevens Creek the only conveyance for upper watershed flow. Thus, lower Permanente Creek typically conveys very little of its upper watershed flow.

0This is not the way the flow split at the diversion was envisioned. Approximately 60 percent of the flowrate was to be conveyed via the diversion, with the other 40 percent flowing down Permanente Creek. This incorrect flow split further reduces the already limited capacity of the Permanente Diversion by eliminating any flow from being carried by the natural channel downstream. The effect is that the capacity of this location is reduced to just the capacity of the Diversion.

IV. No Project Alternative

This section of the report describes how things may change with the previously identified facility problems if no action is taken.

The concrete channel work conducted in the 1960s through the 1980s (especially the Diversion of the majority of upstream flows to Stevens Creek) did reduce flooding in the project area; however, the threat of flooding from even moderate-sized flow events remains. The floods of 1995 and 1998 were not very significant events in the Permanente watershed; but they still caused some damage.

As stated above, very few reaches of the project area have full one-percent flood capacity; therefore, if no changes are made, the area will continue to be subject to the potential for severe damages from the one-percent as well as lesser floods. Permanente Creek flooding would begin at the Diversion, with flood waters tending North across Mountain View to pond just South of Highway 101. Hale Creek flooding would begin at Covington Road, with floodwaters spreading South and East to join with Permanente floodwaters. A one-percent flood would continue to have the potential for causing damages to hundreds of acres of land and upward of two-thousand properties.

As the creek facilities continue to deteriorate structurally, the flooding problem will be exacerbated, unless expensive maintenance work is performed on a piecemeal basis (as different sections of the creek fail). A 212-foot section of the concrete channel which was in danger of imminent failure was recently rebuilt by the District at a cost of approximately $640,000.

The No Project alternative will mean that maintenance access will continue to be spotty and difficult in most of the project area. It would be nearly impossible to repair a failed section of concrete channel during a flow event.

Finally, the No Project alternative severely limits the possibility of environmental rehabilitation or restoration of any portion of the creek.

Figure 17 – Channel Types

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Figure 18 – Remaining Channel Life

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ATTACHMENT 1

HYDROLOGY REPORT

ATTACHMENT 2

LEVEL I HAZMAT INVESTIGATION

EXECUTIVE SUMMARY

Prepared by D&M Consulting Engineers Inc.

ATTACHMENT 3

STRUCTURAL INTEGRITY STUDY

EXCECUTIVE SUMMARY

Prepared by Biggs Cardosa Associates

ATTACHMENT 4

PUBLIC COMMENTS ON INITIAL TWO SCOPING MEETINGS

January 29, 2002 and March 10,2003